ORIGINAL PAPER

Effects of varying nitrogen fertilizer application rates on chemical composition of permanent grassland in Turkey

Received for publication, December 12th, 2014
Accepted, June 7th, 2015

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Abstract

The aim of this study was to determine the chemical changes in the pasture affected by different doses of nitrogen fertilizers and harvest times. It was carried out at Central Anatolian Region during the seasons of 2011 and 2012. Experimental plots were formed by 7 m x 12 m. Nitrogen was applied six doses (annual rate of fertilizer N) as organic nitrogen fertilizer (0, 10, 20, 30, 40, 50 and 60 kg N ha^{-1}). Each plot was harvested 3 times (20th of May, 18th of July and 15th of September in the first year and 15th of May, 20th of July and 12th of September in the second year). Botanical composition of grass samples was determined for each plot and then chemically analyzed. Among the grass species Festuca ovina, Tymus, Astragalus sp., Artemisia and Agropyron repens were dominant. Increased N rates, from 0 to 50 kg N ha^{-1}, caused to increase botanical composition constantly but number of plants was decreased. Crude protein content (2.85 g/kd DM), digestible dry matter (13.53 g/kg), digestible protein ratio (0.0015 g/kg DM) and ash content (128.3 g/kg DM) reached to highest levels at 40 kg *N ha^{-1} while* the highest value of dry matter yield at 50 kg *N ha^{-1}. In contrast,* Water Soluble Carbohydrate decreased constantly. *Results of this study revealed that harvest times also had significant effects on chemical compositions of permanent grassland*

Keywords: Nitrogen fertilizer, grassland, harvest time, botanical composition

1. Introduction

Grassland is the most important land for animals in Turkey but most of the beef, dairy and sheep production systems (more than 90 %) merely are based on total feed nutrient coming from non-grazing sources (ALTIN & al. [1]). In agricultural holding, it is important that reducing the total cost of production is a necessary component of most commercial farming business. Provision of feed to livestock accounts for at least 75% of direct cost in virtually all beef, dairy and sheep production systems (ANONIMOUS [2]). Ruminants can generally be provided with energy from well-managed, home produced grazed grass mode cheaply than from any other feedstuff (O'KIELY & al. [3]).

Soil nitrogen content is frequently limiting factor for plant growth (GALLOWAY & al. [4]). Fertilization and other agronomic applications are essential to get high yield and quality of product in agriculture (AKÇA & al. [5]). It is difficult to determine the effect of fertilization on pasture (YAVUZ and KARADAĞ [6]). Fertilization can affect the chemical composition and the quality of herbage. On the other hand, N fertilizer has effects on botanical and chemical composition of pasture or grassland ecology on the composition of the

N fraction, and on the amounts of other elements taken up (WHITEHEAD [7]). N also limits growth in grasslands (GILLIAM [8]). Many environmental and management factors affect the yield of grass grown especially for silage production. Moreover, climatic variability and climatic extremes characterize the structure of the pasture in Turkey (KOÇ & al.[9]). WHITEHEAD [7] showed an almost linear increase in herbage yield depending on application rates between 250 and 400 kg N ha^{-1} $year^{-1}$, and beyond which the response declines until the maximum yield is attained. BOUWMAN & al. [10] explained that nitrate fertilization is more effective in pasture than the field of agriculture. N fertilizers can play an important role in pasture management (VOURLITIS & al. [11]). Especially, nitrogen regulates chemical structure in botanical composition (BRENNER & al. [12]).

There is a correlation between biochemical action and availability of nitrogen in plants (BRISKE and HEITSCHIMIDT [13]). Additional nitrogen rates increase photosynthesis activity linearly and increasing photosynthesis activity provides dry matter accumulation (MATSON [14]; FIELD and MOONEY [15]). Structure of living plants consists of 1.5-2.0% of dry matter (HUSTON and PINCHAK [16]). KEATING and O'KEELY [17] compared the output of beef carcass per ha when cattle were offered the silage made from the annual production of old permanent grassland, *Lolium perenne* and *Lolium multiflorum* swards. All swards received the same annual input of fertilizer N (430 kg N ha^{-1}) in each year. Some comparisons exist for the yield response of old permanent grassland under cutting regimes to increasing rates of N fertilizer (HOPKINS & al. [18]; SHELDRICK & al. [19]). YAVUZ & al [20] explained that application of 21, 32 and 50 kg / ha nitrogen fertilizers have not affected on yield of grass. However, application of 75 kg / ha nitrogen does effected to increase on yield. There are a lot of studies that fresh grass yield increased by nitrogen fertilization of pastures (WHITE and BLACK [21]; ALINOĞLU and MÜLAYIM [22]; BULLITA and CAREDDA [23]). MOSIER & al [24] found that nitrogen fertilization and cultivation can both decreased CH_4 uptake and increased N_2O production, thereby contributing to the increasing atmospheric concentrations of these gases.

Fertilizer application to grasslands in Turkey is not common practice and most of the pastures are degenerated because of excessive and early grazing. For this reason Pasture grass yield has dropped about 15-20 kg/ha for recent years. Pastures should be re-efficient (YAVUZ & al. [20]) by breeding and fertilizer application and then dry matter yield can be increased gradually. The aim of this study was to determine the effects of applied N fertilizer and harvest time on the yield, nutritive value and insolubility characters of permanent grass

2. Materials and Methods

This experiment was carried out on natural grassland sward in Central Anatolian Region of Turkey. Grassland geo-characteristics were showed altitude of 1020 m and slope of the 2 %. The average rainfall was 327 mm and 318 mm in 2011 and 2012, respectively. The average monthly temperature was 12.7 °C and 13.1 °C for both years while long term weather data for average temperature and rainfall was 12.7 °C and 321 mm, respectively. Soil characteristics were clay loam, salt-free, slightly alkaline, and calcareous, a low amount of potassium, phosphorus and organic matter. The experiment was arranged in a split plot design with four replicates. Sward type was formed as 7 m x 12 m. Nitrogen was applied at six doses (annual rate of fertilizer N) as organic nitrogen fertilizer (0, 10, 20, 30, 40, 50 and 60 kg N ha^{-1}). Nitrogen was applied by hand as ammonium nitrate for the primary growth on February 18^{th} and March 19^{th} in each year.

On each harvest date, a sward of 7 m x 12 m was cut from each plot using a reciprocating-blade to stubble high of 6 cm. The apparent recovery of N fertilizer was calculated as the amount of N in the herbage of a fertilized sward, minus the amount in the herbage of an unfertilized sward, expressed as a proportion of the fertilizer N applied (KEATING AND O'KELLY, [17]). Each plot was harvested 3 times for each season (Table 1). Grass samples from each sub-plot were processed and chemically analyzed. Dry matter yield (DMY), crude protein (CP), dry matter digestibility (DMD), digestible protein (DP), water soluble carbohydrate (WSC) and ash concentration (AC) were determined. Chemical analysis was done according to Association of Official Analytical Chemists (AOAC) Method. Botanical composition was determined and plants were separated according to their genus. Botanical composition was determined in transect-loop method. All measurements are based on bottom coating (SMITH [25]). Also plant coverage area by the total number of species was determined.

In this study, the static closed opaque chamber was made of 8-mm-thick black of acrylic material with a tinfoil reflecting surface covering each side. The inner dimension of the chamber was 50 x 40 x 30 cm (QI & al. [26]). During the measurement, the sampling chambers were put into the groove of a stainless steel chamber base which was inserted into the soil to a depth of 5 cm, and the groove was sealed with distilled water (PENG & al. [27]). All the samples were taken at a relatively uniform time. The sward tiller density data were subjected to analysis of variance using a model that had sward type and annual application of N and their interaction as source of variation. Main and interaction effects were compared using Duncan's multiple range test (DUNCAN [28]).

Herbage yield and chemical composition data were pooled within growth for each sward for both years. Quadratic model ($Y=a+bX+cX^2$) was examined and the model that best fitted the data was chosen based on the R^2 (Coefficient of Determination) and MSE (Mean square error) values. Cumulative yield data were analyzed for both years combined

Table 1. Harvest dates for each sward in 2 years

Growth	Harvest Date	
	1 year	**2 year**
1	22 May	17 May
2	16 July	18 July
3	16 September	15 September

3. Results and Conclusions

Nitrogen applications had a little effect on the botanical composition of grassland at both seasons. Number of species varied significantly with nitrogen applications (Table 2). All of the species were encouraged by nitrogen application. Botanical composition varied according to the rate of N fertilizer. *Festuca ovina*, *Tymus*, *Astragalus sp.*, *Artemisia* and *Agropyron repens* covered on areas more than other species, which were dominant. *Dactylis glomerata*, *Poa pratensis*, *Phleum pratensis*, *Bromus ineermis* and *Bellis perennis* covered lower grassland area, which constituted stable and permanent vegetation. Same type or ruderal vegetation becomes the main plant growth in their place in nature as time progresses (JACKSON [29]).

Annual and perennial native grasses dominated initially in the swards. Two years responses were qualitatively similar. Main effects of N were significant for annual grasses. N affected more slightly perennial grasses than annual grasses. Analysis of variance showed insignificant results according to the differences between them. Botanical composition increased constantly until 50 kg N ha^{-1} with increasing of N rate from 0 to 60 kg N ha^{-1}. At 60 kg ha^{-1}, number of plants decreased. Whether in the non-fertilized plots or in the fertilized plots, botanical composition showed a wide range of variation, with higher N effluxes. Similar variations of botanical composition rates mainly resulted from the similar seasonality of temperature and soil moisture conditions (PENG & al. [27]).

The Results of Duncan's multiple range tests according to chemical characters were given in Table 3. DMY, CP, DMD and DP had higher values in the first harvest time than other harvest times. WSC had the highest value in the second harvest period. However, AC had higher value than others in the period of the third harvest time. Plant nutrient concentration of N demonstrated that the added nutrients were encouraged for plant uptake in grasses (HUENNEKE & al. [30]).

Table 2. Botanical composition mean of Swards at the end of 2 years (1 m^2)

Familia	Species	Nitrogen Application (kg/ha)						
		0	10	20	30	40	50	60
Gramineae	*Festuca ovina*	1.7	1.8	2.0	2.7	3.8	4.9	4.3
Labiate	*Tymus*	1.5	1.5	2.0	2.5	3.0	3.8	3.5
Leguminoseae	*Astragalus sp.*	1.6	1.9	2.0	2.8	3.4	4.1	3.8
Compositae	*Artemisia*	1.2	1.3	1.4	1.7	2.0	2.2	1.9
Gramineae	*Agropyron repens*	1.1	1.1	1.3	1.7	2.3	2.4	2.1
Gramineae	*Dactylis glomerata*	0.7	0.7	0.7	1.1	1.6	1.8	1.8
Gramineae	*Bromus inermis*	0.2	1.2	2.4	2.7	2.4	3.6	3.1
Gramineae	*Poa sp*	0.3	0.5	0.8	1.1	1.3	1.4	1.4
Gramineae	*Phleum pratense*	0.7	0.9	1.3	1.3	1.8	2.0	1.7
Asteraceae	*Bellis perennis*	0.9	0.9	1.2	1.4	1.5	1.5	1.5
Scrophulariaceae	*Verbascum*	0.2	0.2	0.3	0.5	0.5	0.8	0.9
Asteraceae	*Centauria*	0.1	0.3	0.3	0.6	0.7	0.9	1.1
	*Other**	0.8	0.9	1.1	1.3	1.9	2.1	2.4

There are significant differences between the harvest times. According to the rate of nitrogen fertilizer, dry matter yield ranged from 6.03g/kg DM (0 kg/ha N application) to 19.72 (40 kg/ha N application). The highest dry matter was taken in May harvest, whereas the lowest dry matter was taken in September harvest (Table 3). The highest dry matter yield occurred in 40 kg N ha^{-1} application. Fertilization leaded to higher lengths of the plant with higher plant density and increased diversity of plants (SIMON and LEMAIRE [31]). The responses of various species to nitrogen applications can be a response for competition to environmental conditions. Especially, AC was quietly high. This may be due to the large number of plant species in pastures from other families. It is explained that the amount of biomass and ash contents are increased with fertilization in the pasture (GONZALEZ & al. [32]; HEGGENSTALLER & al. [33]; YAVUZ and KARADAĞ [6]).

The highest digestible dry matter only detected in the first harvest. While second and third harvest times occurred 40 kg ha^{-1}, crude protein increased steadily with increasing of N rate. The highest crude protein occurred 60 kg ha^{-1} in all harvest times. For each growth of grassland, rate of nitrogen fertilizer application progressively reduced dry matter accumulation. The grass swards showed the same trends with overall nitrogen doses. All characters at N_0 tended to be lowest at all harvest dates but in the second harvest date they tended to be the highest. The elevated rates of N steadily increased all the characters progressively until 60 kg/ha after then all characters were decreased. Species differed clearly in their response to nutrient resources. These results are similar as increasing the amount of nitrogen fertilizer and the biomass increases (HUENNEKE & al. [30]). However, as studies of HUENNEKE & al. [30] indicated that the invasive plant has been increased; HOBBS and MOONEY [34] explained botanical composition and ecosystem process of grassland are determined by climatic conditions.

Table 3. The Results of Duncan's multiple range tests according to DMY and chemical

Ccharacter	Harvest Time	Nitrogen Fertilizer (kg/ha)							
		0	10	20	30	40	50	60	Mean
DMY	1	6.12j	7.41hı	16.41de	21.36ab	22.48a	22.35a	20.42b	**16.65a**
	2	5.87k	6.84ı	11.36g	16.21e	18.44c	18.55c	16.75de	**13.43b**
	3	6.11jk	6.41hı	10.25g	16.32e	18.25c	17.53cd	14.26f	**12.73b**
Mean		**6.03d**	**6.88d**	**12.67c**	**17.96b**	**19.72a**	**19.47a**	**17.14b**	
CP	1	0.97ı	1.63g	2.16e	2.25e	2.88c	3.15ab	3.18a	**2.32a**
	2	1.01ı	1.24h	1.56g	2.21e	2.87c	2.90c	3.01b	**2.11ab**
	3	0.99ı	1.06ı	1.12h	1.52g	1.98f	2.56d	2.68d	**1.70b**
Mean		**0.99g**	**1.31f**	**1.61e**	**1.99d**	**2.57b**	**2.85a**	**2.96a**	
DMD	1	4.16j	6.87g	9.84f	16.12a	16.28a	16.11a	15.04b	**12.06a**
	2	4.06j	5.92h	7.64g	11.12e	12.54c	12.43c	11.87cde	**9.36b**
	3	5.01ı	5.16ı	6.98g	9.87f	11.52de	12.01cd	11.63de	**8.88b**
Mean		**4.41de**	**5.98d**	**8.15c**	**12.37b**	**13.45a**	**13.53a**	**12.85ab**	
DP	1	0.0007j	0.0007j	0.0009h	0.0012f	0.0016b	0.0015c	0.0014d	**0.0011a**
	2	0.0004l	0.0005k	0.0005k	0.0008ı	0.0012f	0.0017a	0.0011g	**0.0008b**
	3	0.0005k	0.0005k	0.0008ı	0.0013e	0.0014d	0.0014d	0.0011g	**0.0010a**
Mean		**0.0005f**	**0.0026a**	**0.0022a**	**0.0011e**	**0.0014b**	**0.0015b**	**0.0012c**	
WSC	1	19g	19g	18h	18h	17ı	17ı	16j	**17.71c**
	2	25a	25a	25a	24b	23c	23c	20f	**23.57a**
	3	22d	21e	21e	21e	21e	20f	19g	**20.71b**
Mean		**22.0a**	**21.7ab**	**21.3ab**	**21.3ab**	**20.3bc**	**20.0c**	**18.3d**	
AC	1	90g	92g	99f	108e	121d	131bc	128c	**109.8b**
	2	91g	92g	95fg	97fg	106e	109e	108e	**99.71c**
	3	96fg	97f	98f	108e	132bc	145a	142a	**116.85a**
Mean		**92.3 e**	**93.6de**	**97.3d**	**104.3c**	**119.7b**	**128.3a**	**126.0a**	

WSC concentration in DM increased progressively but was more stable than other characters. Increasing rate of N fertilizer tended to reduce WSC concentration at all harvest times. WSC concentration had the highest value at N_0. According to harvest time, the highest values for all characters were measured at first harvest, except WSC and AC. While WSC had high value in the second harvest time, AC was highest at third harvest time. All features increased with increasing nitrogen doses except WSC, which decreased with increasing doses.

KEATING and O'KIELLY [35] showed that digestibility decreased during ensilage. Digestibility declined at first and the third harvest dates but in the second harvest date it reached the highest value. Crude protein declined with increasing rates of N fertilizer application. HOPKINS & al. [18] explained the annual yields of digestible DM and crude protein followed a similar manner. This explanation encouraged our results. WEISSBACH [36] explained that the nitrate can pay an important role in inhabiting clostridia activity during ensilage. In addition, nitrogen had important role since in the structure of living plants, N consist of 1.5-2.0% of dry matter (HUSTON and PINCHAK [37]).

Table 4. Best fit response curves of characters measured under the N applications (2 years pooled)

Harvest Date	Character	R^2	MSE	Nitrogen rate (kg/ha)						
				0	10	20	30	40	50	60
1	DMY (g/kg)	0.74	2.15	6.12	7.41	16.41	21.36	22.48	22.35	20.42
	CP (g/kg DM)	0.76	2.13	0.97	1.63	2.16	2.25	2.88	3.15	3.18
	DMD (g/kg)	0.68	3.15	4.16	6.87	9.84	16.12	16.28	16.11	15.04
	DP (g/kg)	0.78	2.06	0.0007	0.0007	0.0009	0.0012	0.0016	0.0015	0.0014
	WSC (g/l)	0.75	2.13	19	19	18	18	17	17	16
	AC (g/kg KM)	0.72	2.21	90	92	99	108	121	131	128
2	DMY (g/kg)	0.81	2.68	5.87	6.84	11.36	16.21	18.44	18.55	16.75
	CP (g/kg DM)	0.81	2.75	1.01	1.24	1.56	2.21	2.87	2.90	3.01
	DMD (g/kg)	0.90	2.16	4.06	5.92	7.64	11.12	12.54	12.43	11.87
	DP (g/kg)	0.67	6.75	0.0004	0.0005	0.0005	0.0098	0.0012	0.0017	0.0011
	WSC (g/l)	0.73	4.95	25	25	25	24	23	23	20
	AC (g/kg KM)	0.81	2.71	91	92	95	97	106	109	108
3	DMY (g/kg)	0,66	3,18	6,11	6.41	10,25	16,32	18,25	17,53	14,26
	CP (g/kg DM)	0.74	2.42	0.99	1.06	1.12	1.52	1.98	2.56	2.68
	DMD (g/kg)	0.57	5.82	5.01	5.16	6.98	9.87	11.52	12.01	11.63
	DP (g/kg)	0.85	2.39	0.0005	0.0005	0.0008	0.0013	0.0014	0.0014	0.0011
	WSC (g/l)	0.69	3.24	22	21	21	21	21	20	19
	AC (g/kg KM)	0.71	2.64	96	97	98	108	132	145	142

Coefficient of determination varied according to the characters. R^2 ranged from 0.68 (DMD) to 0.78 (DP) in the first harvest. It ranged from 0.67 (DP) to 0.90 (DMD) and from 0.57 (DMD) to 0.85 (DP) at the second and third harvest dates, respectively (Table 4). Mean squared error (MSE) showed similar pattern as coefficient of determination. Quadratic model for describing the some chemical characters of plant has been described. The best model has a lower residual mean square error. In this study lower MSE has 2.06 (DP), 2.16 (DMD) and 2.39 (DP) according to the harvest times respectively. The biological assumption behind quadratic equation differed on all characters and these should be taken into account in utilizing for a particular application. The results of this experiment supported those of RYDEN [38] showing that increasing the N application rate increases the percentage of fertilizer N emitted.

The results of this study showed a good indication of the significance of nitrogen application practices during the growing season. It would be of particular importance to understand how differences in nitrogen doses are linked to the development of soil organic matter content. As a result, harvest time had significant effects on chemical compositions of permanent grassland. Because of this, importance of harvest time needs to be taken into account in grassland management. Grasslands should be fertilized in between 40 and 50 kg/ha in rainy periods. In addition, soil moisture status and temperature are considered due to probably key factors that affect the relative rates of nitrification, denitrification, N production and N consumption (FIRESTONE and DAVIDSON [39]). In future, grassland productivity will possibly be affected by climate change depending on conditions of areas. But, fertilization, especially N fertilizer, can help to mitigate unexpected effects of climate change on grasslands.

References

1. ALTIN, M., GÖKKUŞ, A., KOÇ, A. Pasture and Grassland Improvement. Republic of Turkey, Ministry of Agriculture. p; 468. (2005).
2. ANONIMOUS. Date of Turkish Ministry of Agriculture. Ankara, Turkey, (2005).
3. O'KIELY, P., MOLONEY, A.P., KILLEN, L., SHANNON, A. A computer program to calculate the cost use of providing ruminants with home-produced feedstuffs. *Computers and Electronics in Agriculture.* 19:26-36. (1997).
4. GALLOWAY, M. M., CHHABRA, P. S., CHAN, A. W. H., SURRATT, J. D.,FLAGAN, R. C., SEİNFELD, J. H., AND KEUTSCH, F. N. Glyoxal uptake on ammonium sulphate seed aerosol: reaction products and reversibility of uptake under dark and irradiated conditions, *Atmos. Chem. Phys. Discuss*., 8: 20799–20838. (2008).
5. AKÇA, H., SAYILI, M., ESENGÜN, K. An economic analysis of nitrogen and phosphorus fertilization in sunflower production under irrigated conditions. Proceeding of XXIXth Annual Meeting of ESNA. September 7-12, Wye-Kent-UK, Published by *Austrian Research Centers*.136 – 142. (1999).
6. YAVUZ, T., KARADAĞ, Y. The effect of fertilization and grazing applications on root length and root biomass of some rangeland grasses. *Turk. J. Field Crops*. 20 (1):38-42. (2015).
7. WHITEHEAD, F. '*Grassland Nitrogen*'. CAB International, Wallingford, Oxon, UK. 397 pages. (1995).
8. GILLIAM, F.S. The chemistry of wet deposition for a tallgrass prairie ecosystem: inputs and interactions with plant canopies. *Biogeochemistry*,4: 203–217. (1987).
9. KOÇ, A., GÖKKUŞ A., ALTIN, M. Pasture condition detection in the world, widely used in the comparison of methods and a proposal for Turkey. Turkey 5. *Field Crops Congress*, 13-17 October 2003, Diyarbakır/Turkey. (2003).
10. BOUWMAN, A.F.,VAN VUUREN, D.P., DERWENT, R.G., POSCH, M. A Global Analysis of Acidification amd eutrophication of terrestrial ecosystem. *Water, Air and Soil Pollution*. 141:349-382. (2002).
11. VOURLITIS, G.L., ZORBA, G., PASQUINI, S.C., MUSTARD, R. Chronic nitrogen deposition enhances nitrogen mineralization potential of semiarid shrub land soils. *Soil Science Society of America Journal*, 71, 836–842. (2007).
12. BRENNER, R., BOONE, R.D., RUESS R.W. Nitrogen additions to pristine, high-latitude, forest ecosystems: consequences for soil nitrogen transformations and retention in mid and late succession. *Biogeochemistry*,72:257–282. (2005).
13. BRISKE, D.D., HEITSCHIMIDT, R.K. An ecological perspective. In: Grazing Management an Ecological Perspective. (Eds, R.K: Heitshmidt and J.W. Stuth). Timber Press. Oregon. p; 11-26. (1991).
14. MATSON, W.J.JR. Herbivore in relation to plant nitrogen content. Ann. Rev. *Ecol. Syst*. 11:119-161. (1980).
15. FIELD, C., MOONEY, H.A. The photosyntesis-nitrogen relationships in wild plants. In: On the Economy of Plant Form and Function. (Ed: T.J. Givnish). Cambridge Univ. Press. Cambridge. p; 25-55. (1986).
16. HUSTON, J.E., PINCHAK, W.E. Range animal nutrition. In: Grazing Management an Ecological Perspective. (Eds, R.K: Heitshmidt and J.W. Stuth). Timber Press. Oregon. P. 27-63. (1991).
17. KEATING, T., O'KIELY, P. Comparison of olad permanent grassland, *Lolium perenne* and *Lolium multiflorum* swards grown for silage. 3. Effects of varying fertilizer nitrogen application rate. *Irısh Journal of Agric. and Food Res*. 39: 35-53. (2000).
18. HOPKINS, A., GILBEY, J., DIBB, C., BOWLING, P.J., MURRAY, P.J. Response of permanent and reseeded grasland to fertilizer nitrogen. 1. Herbage production and herbage quality. *Grass and Forage Sci*. 45:43-56. (1990).
19. SHELDRICK, R.D., LAVENDER, R.H., MARTYN, T.M. Dry matter yield and response to nitrogen of an *Agrostis stolonifera* dominant sward. *Grass and Forage Sci*. 45:203-213. (1990).
20. YAVUZ, T., BÜYÜBURÇ, U., KARADAĞ, Y. The effects of fertilization, resting and artificial range establishment methods on yield and quality of natural ranges. *TABAD* 1(1):37-42. (2008).
21. WHITE, J.R., BLACK, A.L. Range fertilization, Plant response and Water use. J. *Range Management* 32(8):345-349. (1979).
22. ALINOĞLU, M., MÜLAYIM, M. Research on the effects of some chemical fertilizers and natural meadows and pastures of the grass yield in Ankara conditions. Republic of Turkey, Ministry of Agriculture and Forestry General Directorate of Agricultural Affairs Publications No:78, Ankara. (1982).
23. BULLITTA, P., CAREDDA, S. Nitrogen-Phosphorus fertilizing of upland grassland. *Studi Sassaresi* 28:286-294. (1982).

24. MOSİER, A., SCHİMEL, D., VALENTİNE, D., BRONSON, K., PARTON, W. Methane and nitrous oxide fluxes in native, fertilized and cultivated grasslands. *Nature* **350**, 330 – 332. (1993).
25. SMİTH, J.G. An Appraisal of the Loop Transect Method For Estimating Root Crown Area Changes. *J. Range Management*, 15(2):72-78. (1962).
26. QI, Y.C., DONG, Y.S., LIU, J.Y., DOMROES, M., GENG, Y.B., LIU, L.X., YANG, X.H. Effect of the conversion of grassland to spring whe at field on the CO2 emission characteristics in Inner Mongolia. *Soil Till.Res*, 94, 310-320. (2007).
27. PENG, Q., DONG, Y., Qİ, Y., XİAO, S., HE, Y., MA, T. Effects of nitrogen fertilization on soil respiration in temperate grassland in Inner Mongolia, China. *Environ Earth Sci*. 62(6):1163-1171. (2011).
28. DUNCAN, D.B. Multiple range and multiple F- tests. Biometrics, 11:1-42. (1955).
29. JACKSON, L.E. Ecological origins of California's Mediterranean grasses. *Journal of Biogeography* 12:349-361. (1985).
30. HUENNEKE, L.F. HAMBURG, S.P., KOIDE, R., MOONEY, H.A., VITOUSEK; P.M. Effects of soil resources on plant invasion and community structure in Californian serpentine grassland. *Ecology*,71(2): 478-491. (1990).
31. SIMON, J.C., LEMAIRE, G. Tillering and Leaf area index in grasses in the vegetation phase. Grass and Forage Science. 42:373-380. (1987).
32. GONZALEZ, R.M., SOSEBEE, R.E., WAN, C. Shoot and root biomass of desert grasses as affected by biosolids application. *J. Arid. Environ*. 50:477-488. (2002).
33. HEGGENSTALLER, A.H.,MOORE, K.J., LİEBMAN, M., ANEX, R.P. Nitrogen influences biomass and nutrient partitioning by perennial, warm-season grasses. *Agronomy Journal*. 101:1363-1371. (2009).
34. HOBBS, R.J., MOONEY, H.A. Community and population dynamics of serpentine grassland annuals in relation together disturbance. *Oecologia*, 67:342-351. (1985).
35. KEATING, T., O'KIELY, P. Comparison of olad permanent grassland, *Lolium perenne* and *Lolium multiflorum* swards grown for silage. 1. Effects on beef production per hectare. Irish *Journal of Agric. and Food Res*. 39: 1-24. (2000).
36. WEISSBACH, F. New developments in crop conservation. Proceeding of the 11th International Silage Conference, University of Wales, Aberystwyth. September 1996: 11-25 p. (1996).
37. HUSTON, J.E., PINCHAK, W.E. Range animal nutrition. In: Grazing Management an Ecological Perspective. (Eds, R.K: Heitshmidt and J.W. Stuth). Timber Press. Oregon. P. 27-63. (1991).
38. RYDEN J.C. (1983). Denitrification loss from a grassland soil in the field receiving different rates of nitrogen as ammonium nitrate. *J Soil Sci.* 34. 355-365.
39. FIRESTONE, M.K AND DAVIDSON E.A. Microbiological basis of NO, and N_2O production and consumption in soil. In: Andreae MO and Schimel DS (eds) Exchange of Trace Gases between Terrestrial Ecosystems and the Atmosphere, Life Sciences Research Report 47, pp 7-21.John Wiley and Sons, Chichester. (1989).