Grazing Intensity and Frequency on Seasonal Biomass Production in Jojoba (*Simmondsia chinesis*)*

Hussein E. Osman and Atallah Abo Hassan
Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University, P.O. Box 9034, Jeddah 21413, Saudi Arabia

ABSTRACT. Two trials were conducted to evaluate the effect of annual grazing (pruning) and seasonal grazing (four times a year) on total green foliage weight (TGFW), total dry foliage weight (TDFW), culm dry weight (CDW), leaf dry weight (LDW), total leaf area (TLA), specific leaf area (SLA) and N-content (protein) of both culms and leaves. Three grazing intensities (pruning 25, 50 and 75% of vegetative growth) were evaluated in each trial. Data taken at the end of each of eight consecutive seasons (from 21/6/94 until 21/3/96) revealed differences ($P < 0.05$) among seasons for all of the traits studied in the annual grazing trial (both years, for SLA) and for TGFW, SLA and N-content of leaves and culms in the first year and for TLA in both years in the seasonal grazing trial. The interaction of season and pruning intensity in the annual grazing trial significantly affected TGFW, TDFW, CDW and LDW in the first year of the study. Dry matter accumulation, under all grazing intensities, progressively increased with plant age under annual grazing but progressively decreased with plant age under seasonal (repeated) grazing practices. Estimates of N-content over the grazing intensities ranged from 2.61% to 3.00% for leaves and from 1.70% to 2.14% for culms over the grazing trials. Thus, rotational annual grazing of jojoba will ensure the availability of high yields of high quality forage throughout the year.

Introduction

Shrub species are major components of arid and semiarid range lands throughout the world and are important sources of forage (browse) for domestic and wild herbivores (Ruyle *et al.*, 1983). Forage production varies within and among species, with age of plant, season and year (Bartolome and Kosco, 1982); whereas nutritive value varies mostly with the growing season (Cook *et al.*, 1967; Parker, 1969; Buchanan *et al.*, 1972; Rosiere and Torell, 1985; Holechek *et al.*, 1989; Tag Eldin, 1993). Estimates of total dry biomass harvested from a group of five species of the genus Atriplex established in Central Saudi Arabia, were reported to be highest in the summer (725kg/ha) and the spring (702kg/ha) and lowest in autumn (518kg/ha) and winter (527kg/ha) (Tag Eldin, 1993).

*This research is supported under the grant AT-13-23 for King Abdulaziz City for Science and Technology.

In Saudi Arabia, most of the irrigation water is saline and drought prevails most of the year. Jojoba (*Simmondsia chinesis*) is known to be a drought tolerant species (Osman and Abo Hassan, 1997) that withstands high salinity levels in the irrigation water (Osman and AboHassan, 1998a) and is capable of maintaining positive growth and low levels of fertilizers (Osman and Abo Hassan, 1998b). Consequently, its introduction as a rangeland shrub under the arid conditions of western Saudi Arabia may prove to be very essential. The utilization of Jojoba as a browse shrub is illustrated in Figure 1, whereas its nutritive value was reported by Osman and Abo Hassan (1997).

The present work was undertaken to assess green and dry foliage production, their components, and the N-content (protein) of leaves and culms in Jojoba under various levels of simulated grazing intensities carried out once a year (annual) or four times a year (seasonal).

Materials and Methods

The present work was conducted at the Experimental Farm of King Abdul Aziz University at Hada Al-Sham located 120km northeast of Jeddah. The soil at the experimental site is sandy clay (72% sand, 18% clay and 10% silt) having an average estimate of 0.17, 0.20 and 2.610g / Kg of N, P and K, respectively at a pH of 8.2 and ECe of 0.960mmhos/cm. The meteorological data characteristic of the experimental site is shown in Table 1. A seed lot of Jojoba introduced from Arizona was seeded in 1989. Seeds harvested from this lot were used in establishing the simulated grazing trials indicated in this study. The test plot was seeded on 28/2/1993 in an area of 0.22ha (10 rows x 400m x 550m) under a drip irrigation system. On 20/9/93 (i.e. 213 days after planting), the test plot was divided into four blocks, each of which, apart from marginal rows, consisted of 2 rows x 40m x 550m. Three of these blocks were used for initiation of the annual grazing trial, whereas the fourth block was allocated for the seasonal or continuous grazing trial. In both trials, a split-plot design was used with three replications, in which the main plot was allocated for grazing (pruning) intensity (i.e. removal of 25, 50 or 75% of shoot growth) and the subplot ($12m^2$) was allocated for the grazing time (21/6, 21/9, 21/12 and 21/3) marking the last day in the spring, summer, fall and winter growing season in each year. In the annual grazing trial the experimental intensity subplots were pruned once a year, whereas in the seasonal grazing trial the same experimental plot was pruned four times a year, i.e. at the end of each growing season every year. At the time of grazing which was initiated on 21/6/94 and continued for eight consecutive seasons, i.e. until 21/3/96 data was taken on total green foliage weight (i.e. fresh weight of harvested shoots) and on total dry foliage weight (i.e. weight of 72hr oven-dried shoots and their oven dried components i.e. leaf and culm weights). Total leaf area per plot was determined by using a leaf area metre (Licor 1000). Nitrogen content was measured by the use of an automatic N-analyzer (Kjeltec Auto 1030). In addition, specific leaf area or SLA, i.e. leaf area/leaf weight, and N-content of both culm and leaves were also determined. Data taken in each of the two years was analyzed as for split-plot design as suggested by Steel and Torrie (1981).

Results

Total Green Foliage Weight (TGFW)

Total harvests of green foliage (TGFW) were significantly affected ($P<0.05$) by the interaction of intensity and growth season for annual grazing and by grazing and season for seasonal grazing in the first year. In the second year, TGFW was affected only by season (Table 2). On the average, the highest harvests were in winter. Grazing 50% yielded the highest in both fall and winter, whereas increasing to 75% grazing was highest in all seasons except fall. Annual grazing appeared to yield higher TGFW than seasonal grazing.

Total Dry Foliage Weight

Total dry foliage weight (TDFW) was affected ($P<0.05$) by the interaction of grazing intensity and season in the annual grazing trial, for both years. These factors did not affect (TDFW) in the seasonal grazing trial (Table 2). On the average, the highest TDFW was recorded at the 75% grazing intensity in the winter of both years. The 75% grazing intensity had the highest TDFW except for fall of the first year and spring of the second year. Increased grazing intensity increased TDFW (Table 4).

Culm Dry Weight

Estimates of culm dry weight (CDW) were affected ($P<0.05$) by the interaction of grazing intensity and growth season in the first year, and by growth season for annual grazing in the second year (Table 2). Highest estimates of CDW were recorded at the 75% grazing intensity in the winter of both years. A 75% grazing yielded highest CDW for annual grazing except in the fall (50% grazing was highest), whereas 50% grazing yielded highest CDW for seasonal grazing (Table 5).

Leaf Dry Weight

Estimates of leaf dry weight (LDW) were affected ($P<0.05$) by the interaction of growth season and grazing intensity in the first year and by growth season in the second year of annual grazing. These factors had no effect on LDW in the seasonal grazing trial (Table 2). Highest estimates were recorded at the 75% grazing intensity in the winter of both years (Table 6).

Total Leaf Area

Estimates of total leaf area (TLA) were affected ($P<0.05$) by growth season in both years for both grazing types (Table 2). Within each year, TLA increased progressively with plant age, except for seasonal grazing in the second year, where TLA was highest in the fall. The summer TLA was the lowest regardless of grazing type in both years (Table 7).

Specific Leaf Area

Specific leaf area (SLA) was affected ($P<0.05$) by growth season in the first year for both grazing types and by grazing intensity for seasonal grazing in both years (Table 2). Highest SLA was recorded for the winter (about double) regardless of grazing type. For seasonal grazing, highest SLA was recorded at 50% grazing intensity, regardless of the year (Table 8).

Nitrogen Content

Nitrogen content in the leaves, regardless of grazing type, was affected ($P<0.05$) by the growth season, whereas that of the culms was affected ($P<0.05$) by both growth season and grazing intensity for the first year (Table 2). In the leaves, lowest estimates of N were recorded in the spring, regardless of grazing type and effect. In the culms, highest estimates of N were recorded in the fall and winter months at the 25% grazing intensity (Table 9).

Discussion

Estimates of TGFW, TFDW, CDW and LDW recorded for the annual grazing trial in the second year appear higher that those recorded in the first year, whereas estimates for TLA and SLA appear relatively higher in the first year. Increase in TGFW in response to annual pruning was mostly attributed to an increase in the number of auxiliary buds activated (Brown and Palzkill, 1990). In a similar trial, Tag Eldin, (1993) indicated that estimates of TGFW in Atriplex harvested in consecutive years were statistically similar, whereas TFDW estimates harvested in the first year were significantly higher than those recorded in the second.

Data in Tables 3 to 8 also revealed that differences among seasons (annual grazing trial) were highly significant for TGFW, TFDW, CDW, LDW and TLA in both years and for SLA in the first year, whereas those recorded for the seasonal grazing trial except for TGFW, TLA and SLA, were generally non-significant. Seasonal estimates of TGFW, TFDW, CDW and LDW recorded for the annual grazing trial (i.e. pruning once a year) progressively increased with plant age; whereas those recorded for the seasonal (continuous) grazing trial seemed to progressively decrease with plant age. Elsewhere, forage production was similarly reported to vary with plant age, growth season and year (Stoddart *et al.*, 1975, Bartolome and Kasoas, 1982).

Jojoba is known to be a relatively slow growing shrub (Yermanos, 1982) and therefore, its ability to regenerate new vegetative growth under continuous grazing is very much limited. Consequently under extended periods of continuous grazing it becomes unproductive and it may eventually die.

Effects of grazing intensity on TGFW, TFDW, CDW, LDW under annual grazing practice (Tables 3 to 6) were generally significant in the first year and non-significant in second; whereas those on TLA and SLA were non-significant in both years. Effects of grazing intensity under seasonal grazing practices on these parameters, except for those on TGFW in the first year and on SLA in both years, were all non-significant (Tables 3 to 8). Such trends, coupled with the lack of significant interactions between grazing intensity and grazing season, especially in the second year of the trials, indicate the ability of jojoba to regenerate new growth throughout the year after grazing. Total biomass regenerated per year under annual grazing practices, especially at the high intensities was, however, relatively higher than that accumulated under seasonal grazing practices.

Reports in the literature indicate that the nutritive value of forages varies tremendously between seasons (Cook *et al.* 1976; Parker, 1969; Buchanan *et al.* 1972; Holechek *et al.* 1989; Tag Eldin, 1993; Osman and Abo Hassan, 1998a, b). Similarly the present findings indicated that estimates of N-content (protein) of jojoba leaves grazed on 21/9, 21/12 and 21/3 seemed higher than those grazed on 21/6, whereas in culms highest estimates were recorded on grazing at 21/12 and 21/3. Differences among seasons in N-content of both leaves and culms were also reported by Osman and Abo Hassan (1998a, b) in Jojoba grown in Western Saudi Arabia. Thus, based on the present findings, implementation of annual rotational grazing practices in managing established Jojoba plots, would most likely ensure the availability of high yields of high quality forage throughout the year.

Table 1: Absolute seasonal maxima and minima of temperature and relative humidity at the experimental site in the periods 21/12/93 to 20/12/96

Season	1993/94		1994/95		1995/96	
	Temp. (°C)	R. H. (%)	Temp. (°C)	R. H. (%)	Temp. (°C)	R. H. (%)
Winter (W)	6 – 40	22 - 98	10 - 42	17- 100	24 - 41	42 - 97
Spring (Sp)	14 - 49	24 - 93	18 - 49	19 - 95	25 - 47	40 - 98
Summer (S)	19 - 48	21 - 100	12 - 48	22 - 95	31 - 49	43 - 100
Fall (F)	14 - 42	22 - 99	20 - 46	21 - 95	22 - 44	60 - 100

Table 2: Summary of significance for annual (A) and seasonal grazing (B) trials.

	First year						Second year					
	Season[a] (S)		Treatment (T)		Interaction (SxT)		Season (S)		Treatment (T)		Interaction (SxT)	
	A	B	A	B	A	B	A	B	A	B	A	B
Total green foliage weight (TGFW)	**	**	*	**	**	N.S	**	N.S	N.S	N.S	N.S	N.S
Total dry foliage weight (TFDW)	**	N.S	**	N.S	**	N.S	**	N.S	N.S	N.S	*	N.S
Culm dry weight (CDW)	**	N.S	*	N.S	*	**	**	N.S	N.S	N.S	N.S	N.S
Leaf dry weight (LDW)	**	N.S	N.S	N.S	**	N.S	**	N.S	N.S	N.S	N.S	N.S
Total leaf area (TLA)	**	**	N.S	N.S	N.S	N.S	*	*	N.S	N.S	N.S	N.S
Specific leaf area (SLA)	**	**	N.S	*	N.S	N.S	N.S	N.S	N.S	*	N.S	N.S
N-content (leaves)	**	**	N.S	N.S	N.S	N.S	-	-	-	-	-	-
N-content (culms)	*	*	*	**	N.S	N.S	-	-	-	-	-	-

a: A and B stand for Annaul Grazing and Seasonal Grazing trials, respectively.
*and ** : Significant at P≤ 0.05 and P≤ 0.01, respectively.

Table 3: Effect of grazing (pruning) and season on total green foliage weight (TGFW) (g) under three grazing intensities.

Grazing intensity	First year					Second year				
	Date of grazing (pruning)									
	Spring 21/6/94	Summer 21/9/94	Fall 21/12/94	Winter 21/3/95	Average	Spring 21/6/95	Summer 21/9/95	Fall 21/12/95	Winter 21/3/96	Average
A. Annual Grazing (Pruning)										
			±212.9**		±207.6*			±877.5		±904.9
25%	323.8	264.9	258.4	294.1	285.3	547.9	1349.4	1327.7	1306.3	1132.8
50%	304.9	702.6	1289.4	2559.7	1139.1	1327.7	1695.5	1923.3	4734.7	2420.3
75%	1303.00	1076.9	825	3036.1	1560.3	1144.5	2524.4	2397.6	2624.7	2672.8
		±122.09**						±506.6**		
Mean (Season)	643.9	681.5	791	1863.3						
Mean (Year)			±994.9		± 379.0			±2075.3		
B. Seasonal Grazing (Pruning)										
			± 110.4		±75.3**			±77.1		± 99.9
25%	148.8	168.4	184.8	288.6	197.6	248.1	270.1	214.9	314.7	262.1
50%	649.4	513.3	337.6	535.4	508.9	323.7	158.6	177.4	99.7	189.5
75%	497.0	203.8	227.8	338.9	316.9	212.1	153.5	171.1	101.7	159.5
			±63.8**					±39.5		
Mean (Season)	431.7	295.2	250.2	387.6		261.3	194.0	187.8	172.00	
Mean (Year)			± 341.2			± 25.3		±203.8		

*and ** : Significant at P≤ 0.05 and P≤ 0.01, respectively.

Table 4: Effect of grazing (pruning) and season on total foliage dry weight (TFDW) (g) under three grazing intensities.

Grazing intensity	First year					Second year				
	Date of grazing (pruning)									
	Spring 21/6/94	Summer 21/9/94	Fall 21/12/94	Winter 21/3/95	Average	Spring 21/6/95	Summer 21/9/95	Fall 21/12/95	Winter 21/3/96	Average
A. Annual Grazing (Pruning)										
	±91.7**				±78.8*	±266.5*				±355.9
25%	110.2	142.5	91.2	300	160.9	236.8	540.1	621.7	826.5	556.3
50%	109.1	236.1	520.7	872.1	434.5	491.6	805.9	863/9	1924.3	1021.4
75%	545.8	447.4	322.8	1164.6	620.1	457.5	1120.3	1123.2	2923.3	1291.7
	±52.9**					±153.8**				
Mean (Season)	255.02	275.3	311.5	778.9		395.3	822.1	869.6	1891.4	
Mean (Year)	±405.2					±148.8*		±994.5		
B. Seasonal Grazing (Pruning)										
	±48.8				±25.8*	±52.5				±42.4
25%	47.7	58.7	60.4	99.3	66.4	218.7	115.3	101.1	119.9	138.8
50%	253.9	204.4	118.7	207.4	196.1	184.4	68.1	82.3	55.8	89.4
75%	236.2	69.4	125.7	120.8	138.1	121.9	65.7	79.4	41.9	76.8
	±28.2					±47.4				
Mean (Season)	179.2	110.9	101.6	142.5		174.9	83.0	87.6	72.5	
Mean (Year)	± 133.5					±27.7		±104.5		

*and ** : Significant at $P \leq 0.05$ and $P \leq 0.01$, respectively.

Table 5: Effect of grazing (pruning) and season on culm dry weight (CDW) (g) under three grazing intensities.

Grazing intensity	First year					Second year				
	Date of grazing (pruning)									
	Spring 21/6/94	Summer 21/9/94	Fall 21/12/94	Winter 21/3/95	Average	Spring 21/6/95	Summer 21/9/95	Fall 21/12/95	Winter 21/3/96	Average
A. Annual Grazing (Pruning)										
			±47.5*		±34.9*			±194.3		±210.6
25%	29.3	27.4	25.9	104.9	46.9	1556.3	179.2	226.5	315.8	219.3
50%	29.1	100.4	189.1	361.8	172.6	289.2	291.7	323.8	1234.7	534.8
75%	229.9	182.4	121.1	559.4	273.2	173.5	513.3	473.9	1408.00	644.7
		±27.4**						±112.2**		
Mean (Season)	99.5	103.4	112.2	342.02		209,7	328.1	341.4	986.4	986.2
Mean (Year)			±164,2			±87.2*		±466.3		
B. Seasonal Grazing (Pruning)										
			±18.8**		±11.6			±17.6		±14.6
25%	12.8	19.8	14.7	26.7	28.6	80.8	33.9	43.5	35.1	46.1
50%	91.9	87.3	41.5	81.2	75.5	68.2	20.1	32.6	32.3	30.4
75%	46.7	31.8	45.00	50.6	43.5	45.1	23.5	38.1	32.1	34.7
			±10.8*					±17.1		
Mean (Season)	50.5	46.3	33.7	52.8		64.7	25,8	35.1	33.5	
Mean (Year)			±45.83			±10.3		±39.8		

*and ** : Significant at P≤ 0.05 and P≤ 0.01, respectively.

Table 6: Effect of grazing (pruning) and season on leaf dry weight (LDW) (g) under three grazing intensities.

Grazing intensity	First year					Second year				
	Date of grazing (pruning)									
	Spring 21/6/94	Summer 21/9/94	Fall 21/12/94	Winter 21/3/95	Average	Spring 21/6/95	Summer 21/9/95	Fall 21/12/95	Winter 21/3/96	Average
A. Annual Grazing (Pruning)										
			±50.5**		±49.6*			±161.9		±152.7
25%	80.8	115.1	65.2	216.9	119.5	94.7	360.9	395.2	510.7	340.4
50%	69.9	135.7	313.6	568.9	272.1	202.4	514.2	540.2	712.9	492.4
75%	315.9	265	201.6	693.5	369	114.1	606.7	649.3	1515.3	721.4
			±29.2**					±93.5**		
Mean (Season)	155.6	171.9	193.5	493.1		137.1	493.9	528.2	912.9	
Mean (Year)			±253.5			±65.6*		±518.1		
B. Seasonal Grazing (Pruning)										
			±29.5		±16.6			±37.3		±29.2
25%	34.6	38.6	45.6	72.6	47.9	137.8	81.4	66.6	84.9	92.7
50%	161.6	117.03	77.2	124.5	120.1	116.2	48.1	49.7	21.9	58.9
75%	151.9	37.9	80.9	70.2	85.2	76.8	40.3	41.6	9.8	42.1
		±17.1						±31.4		
Mean (Season)	116.2	64.5	67.9	89.1		110.3	56.7	52.6	38.9	
Mean (Year)			± 84.4			±18.0		±64.6		

*and ** : Significant at $P \leq 0.05$ and $P \leq 0.01$, respectively.

Table 7: Effect of grazing (pruning) and season on total leaf area (TLA) (cm^2) under three grazing intensities.

Grazing intensity	First year					Second year				
	Date of grazing (pruning)									
	Spring 21/6/94	Summer 21/9/94	Fall 21/12/94	Winter 21/3/95	Average	Spring 21/6/95	Summer 21/9/95	Fall 21/12/95	Winter 21/3/96	Average
A. Annual Grazing (Pruning)										
			±302.9		±154.6			±83.6		±41.8
25%	219.1	140.5	237	898.8	373.9	304.8	221.7	254.6	400.4	295.4
50%	230.3	203.7	424.8	2200.1	764.7	388.8	264.96	317.5	630.3	400.4
75%	205.3	203.2	634.1	787.8	457.6	310.7	309.3	425.4	566.4	403.1
			± 174.9**					±47.24*		
Mean (Season)	218.2	182.5	431.9	1295.6		334.8	265.3	332.5	532.5	
Mean (Year)			±532.1			± 64.9		±366.3		
B. Seasonal Grazing (Pruning)										
			±129.7		±49.7			±79.3		±64.5
25%	161.3	132.5	265.2	718.1	319.3	228.1	126.03	234.4	142.00	182.6
50%	251.7	140.3	309.1	1074.6	443.9	408.3	182.00	438.1	116.3	286.2
75%	213.2	141.00	481.3	810.3	411.4	236.4	166.7	62.00	76.00	135.2
			± 74.8**					±45.8*		
Mean (Season)	208.8	137.9	351.8	867.7		291.00	158.22	244.8	111.4	
Mean (Year)			±391.5			±33.2**		± 201.3		

** : Significant differences at P≤ 0.01.

Table 8: Effect of grazing (pruning) and season on specific leaf area (TLA) ($cm^{2/g}$) under three grazing intensities.

Grazing intensity	First year					Second year				
	Date of grazing (pruning)									
	Spring 21/6/94	Summer 21/9/94	Fall 21/12/94	Winter 21/3/95	Average	Spring 21/6/95	Summer 21/9/95	Fall 21/12/95	Winter 21/3/96	Average
A. Annual Grazing (Pruning)										
			±6.7		±3.1			±3.5		±1.1
25%	29.2	38.1	37.5	93.2	49.5	30.3	32.00	37.6	34.6	33.6
50%	33.6	42.8	39.2	64.5	45.1	30.8	27.9	29.3	37.7	31.4
75%	27.8	36.4	39.5	89.4	48.3	36.4	32.6	45.5	28.3	35.7
			±3.9**					±2		
Mean (Season)	30.2	39.1	38.1	82.4		32.5	30.8	37.4	33.5	
Mean (Year)			±47.6			±1.4**			±33.6	
B. Seasonal Grazing (Pruning)										
			± 8.4		±1.5*			±7.7		±2.6*
25%	29.2	50.2	44.8	74.9	49.8	33.7	32.2	33.2	42.5	35.4
50%	40.00	39.5	54.2	105.5	59.8	39.6	46.7	49.7	44.5	45.1
75%	30.1	41.6	58.13	86.3	52.6	38.3	50.4	23.3	25.3	34.3
			±4.8**					±4.5		
Mean (Season)	33.1	43.8	50.4	88.9		37.2	43.1	35.4	37.4	
Mean (Year)			±54.03			±1.2**		±38.3		

*and ** : Significant differences at $P \leq 0.05$ and $P \leq 0.01$, respectively.

Table 9: Effect of grazing (pruning) and season on N-content (%) of leaves and culms under three grazing intensities.

Grazing intensity	Leaves					Culms				
	Date of grazing (pruning)									
	Spring 21/6/94	Summer 21/9/94	Fall 21/12/94	Winter 21/3/95	Average	Spring 21/6/94	Summer 21/9/94	Fall 21/12/94	Winter 21/3/95	Average
A. Annual Grazing (Pruning)										
			±0.23		±0.11		±0.12			±0.06
25%	2.03	3.25	3.24	2.99	2.88	1.38	2.12	2.61	2.43	2.14
50%	1.96	3.33	2.95	3.10	2.83	1.20	1.70	2.60	2.38	2.00
75%	1.79	2.81	2.84	3.00	2.61	1.10	1.63	2.10	2.38	1.80
			±0.127**					±0.15*		
Mean (Season)	1.93	3.13	3.02	3.03		1.22	1.80	2.42	2.40	
Mean (Year)										
B. Seasonal Grazing (Pruning)										
			±0.1		±0.06			±0.2		±0.07**
25%	2.13	3.10	3.10	3.12	2.84	1.32	1.86	2.42	2.60	2.05
50%	2.15	3.10	2.93	3.24	2.86	1.11	1.72	2.39	2.46	1.92
75%	2.00	3.20	2.73	3.30	3.00	1.11	1.65	1.68	2.40	1.70
			± 0.06**					±0.12*		
Mean (Season)	2.08	3.10	2.91	3.22		1.81	1.74	2.74	2.16	2.49
Mean (Year)										

*and ** : Significant differences at $P \leq 0.05$ and $P \leq 0.01$, respectively.

References

Bartolome, J.W. and Kosco, H.B. (1982) Estimating browse production by deerbush (*Ceanothus integerrirnus*). J. Range Mangt. **35**: 671-672.

Brown, J. and Palzkill, D.A. (1990) Processing and marketing Jojoba oil and derivatives. Presentation at the closing seminar of the Reginoal FAO/UNDP Jojoba Project, (RAB/84/035). Sanaa, Yemen Arab Republic, 18-21 March, 1990.

Buchanan, H., Laycock, W.A. and Price, D.A. (1972) Botanical and nutritive content of the summer diet of sheep on a tall forb range in southwestern Montana. J. Animal Sci. **35**: 423-430.

Cook, W.C., Harris, L.B. and Young, M.L. (1967) Botanical and nutritive content of diets of cattle and sheep under and common use on mountain range. J. Animal Sci. **26**: 1169-117.

Holechek, J.L., Pieper, R.D. and Herbel, C.H. (1989) Range management, principles and practices. New York, Prentice Hall, 501 p.

Osman, H.E. and AboHassan, A.A. (1997) Jojoba (*Simmondsia chineses* (Link) Scheinder): A potential shrub in the Arabian Desert. II. Effect of drought stress on vegetative growth and nutritive value. JKAU, Metrology, Environmental, Arid Land Agricultural Sci. **8**: 97-107.

Osman, H.E. and Abo Hassan, A.A. (1998a) Jojoba (*Simmondsia chineses* (Link) Scheinder): A potential shrub in the Arabian Desert. III. Effect of saline irrigation on vegetative growth, nutritive values and soil properties. JKAU, Metrology, Environmental, Arid Land Agricultural Sci.. **9**: 71-83.

Osman, M.E. and Abo Hassan, A.A. (1998b) Jojoba (*Simmondsia chineses* (Link) Scheinder): A potential shrub in the Arabian Desert. IV. Effect of NPK fertilization on vegetative growth N-content of leaves. JKAU, Metrology, Environmental, Arid Land Agricultural Sci. **9**: 109-122.

Parker, K.G. (1969) The nature and use of Utah range. Utah State Univ. Ext. Circ. 359, Logan.

Rosiere, RE. and Torell, D.T. (1985) Nutritive value of sheep diets on coastal California annual range. Hilgardia **53**: 1-17.

Ruyle, G.B., Bowns, J.E. and Schlundt, Al. F. (1983) Estimating snowberry (*Symphori carpos oreophilus*) utilization by sheep from twig diameter-weight relations. J. Range Managt. **36**: 472-474.

Steel, R.G. and Torrie, J.H. (1981) Principles and Procedures of Statistics. (2nd ed). McGraw-Hill Book Co., New York, 633 p.

Stoddart, L.A., Smith, A.D. and Box, T.W. (1975) Range Management. McGraw-Hill Book Co., New York, 532 p.

Tag Eldin, S.S. (1993) Effect of grazing season on the productivity parameters of five range shrubs. Arab Gulf J. Scientific Research **11**: 209-219.

Yermanos, D.M. (1982) Jojoba: out of the ivory tower and into the real world of agriculture. Annual report, Agronony Dept., University of California-Riverside, Ca., U.S.A, 101 p.

(Received 30/01/1999; in revised form 20/02/2000)

أثر الكثافة الرعوية وتوقيت الرعي على الانتاج الموسمي للعلف بالهوهوبا *(Simmondsia chinesis)**

حسين الجزولي عثمان و عطا اللّه أحمد أبوحسن

كلية الأرصاد وزراعة المناطق الجافة ، جامعة الملك عبدالعزيز ، ص.ب: 9034 ، جدة 21413

المملكة العربية السعودية

المستلخص : أجريت تجربتان لتقييم آثار الرعي السنوي (التقليم مرة في العام) والموسمي (التقليم أربعة مرات في العام) على إنتاج المادة الخضراء والمادة الجافة ومكونيهما من الأوراق والسوق بالإضافة لمساحة الأوراق ،الكثافة النوعية للأوراق ومحتوى الأوراق والسوق من الأزوت.

اشتملت التجربة على ثلاثة كثافات رعوية ، (تشذيب 25، 50، 75% من النمو الخضري). أخذت البيانات عند نهاية كل موسم من ثمانية مواسم متتالية (من 1994/6/12 إلى 1996/3/21).

أوضحت النتائج وجود فروقات معنوية (P<= 0.05) بين المواسم ، لكل الصفات عدا الكثافة النوعية للأوراق خلال العامين بتجربة الرعي السنوي ولوزن العلف الأخضر وكثافة الأوراق ومحتوى الأزوت بالسوق والأوراق خلال العام الأول وللمساحة الكلية للأوراق خلال العامين بتجربة الرعي الموسمي. كما أثر التفاعل بين الموسم والكثافة الرعوية على الوزن الكلي الرطب والجاف للعلف وعلى وزن السوق والأوراق بتجربة الرعي السنوي خلال العام الأول.

كذلك أوضحت الدراسة وجود زيادة مضطردة في معدلات تجميع المادة الجافة بتجربة الرعي السنوي ونقص مضطرد في معدلات تجميعها بتجربة الرعي الموسمي مع تقدم عمر النبات. أما معدلات الأزوت للمعاملات الرعوية الثلاث ، فقد تراوحت ما بين 2.61 إلى 3% بالأوراق وما بين 1.7 إلى 2.14% بالسوق للتجربتين . وعليه يتضح أن الرعي الدوري السنوي للهوهوبا سيؤمن إنتاجية عالية من الأعلاف ذات الجودة العالية على مدار العام.

---

* هذا البحث مدعوم بالمنحة A-T-13-23 مدينة الملك عبدالعزيز للعلوم والتقنية، الرياض.