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Influence of Excluding Grazing on Vegetation Attributes at the Eastern Slopes of West Bank

أثر منع الرعي على الخصائص الطبيعية للنباتات في السفوح الشرقية من الضفة الغربية

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Abstract

The influence of excluding grazing on range vegetation attributes was studied at the Eastern Slopes of West Bank. Vegetation attributes were compared at a grazed plot and an ungrazed plot in the years 2004 and 2005. Results showed that plant density in the excluding grazing area was (518.9 Plants m^{-2}) higher ($p < 0.05$) than that in grazed plot (194.4 plants m^{-2}) in the year 2005. In addition, total plant cover averaged 94% and 93% in ungrazed plots while 54% and 68% in grazed plots during the years 2004 and 2005 respectively. By April, 70% of plant biomass was already utilized by grazing ruminants, and subsequently induced change in the botanical composition by increasing unpalatable species like: *Sarcopoterium spinosum*, *Asphodelus aestivus*, *Echinops polyceras*, and *Eryngium creticum* in grazed plot. At the ungrazed plot, palatable species such as *Medicago spp*, *Bromus spp*, *Hordeum spp*, *Aegilops spp*, *Poa bulbosa* and *Avena sterilis* were dominant. In addition, vegetation in the ungrazed plot was more diverse than in the grazed plot, moreover, excluding grazing increased species richness by 57 %. Results indicated that overgrazing induced vegetation retrogression and reduced the length of the grazing period for two months only. In conclusion, selection of

suitable grazing management, mainly grazing time and stocking rate, at rangelands in Southern West Bank is an urgent practice that should be implemented to stop the vegetation retrogression trend of these rangelands

Key words: Rangelands, vegetation attributes, dry plant biomass, grazing management, species richness

ملخص

في تجربة حقلية نفذت بين عامي ٢٠٠٤ و٢٠٠٥ تمت دراسة أثر منع الرعي على الخصائص الطبيعية للنباتات الرعوية في منطقة السفوح الشرقية جنوب الضفة الغربية. وقارنت الدراسة الخصائص الطبيعية في منطقة مُنع الرعي فيها مدة تسع سنوات، مع منطقة مفتوحة الرعي بصورة جائرة. وأظهرت النتائج أن كثافة النباتات في المنطقة التي منع فيها الرعي بلغت (٥١٨.٩ نبتة / م٢)، فكانت أعلى من المنطقة مفتوحة الرعي حيث بلغت (١٩٤.٤ نبتة / م٢)، في العام ٢٠٠٥. وتشير النتائج إلى أن نسبة الغطاء النباتي قد انخفضت من ٩٤% و ٩٣% في المنطقة التي منع فيها الرعي إلى ٥٤% و٦٤% في المناطق مفتوحة الرعي خلال العامين ٢٠٠٤ و٢٠٠٥ بالترتيب. وبينت الدراسة أن الحيوانات المُجْتَرّةِ استهلكت حوالي ٧٠% من المادة الجافة للنباتات بحلول شهر نيسان في المناطق مفتوحة الرعي، وهذا أدى إلى تغيير في الأنواع النباتية الموجودة حيث زادت النباتات غير المرغوبة رعوياً مثل: نبات النتش (*Sarcopoterium spinosum*) والغيصلان (*Asphodelus aestivus*) وشوكة الجمل (*Echinops polyceras*) والقرصعنة (*Eryngium creticum*) بينما في المناطق محمية الرعي زادت نسبة النباتات الرعوية. وبينت الدراسة أيضاً أن تعدد الأنواع النباتية في المناطق التي منع الرعي فيها قد زاد عن المناطق مفتوحة الرعي. تشير النتائج أيضا إلى أن الرعي الجائر والمفتوح أحدث تغييراً نحو تدهور المراعي وقلل من فترة الرعي إلى شهرين فقط في السنة. لذلك من أجل وقف تدهور المراعي في جنوبي الضفة الغربية فمن المهم اختيار طرق تنظيم الرعي ولاسيما في موعد فتح المراعي وكثافة الرعي.

Introduction

Understanding and quantifying the effect of grazing on the vegetation community is important for management and conservation of rangelands (Noy-Meir et al, 1989, pp: 290-310. Sternberg et al, 2000, pp: 224-237). Therefore, many researchers have studied the effect of grazing on range vegetation. Beeskow et al (1995, pp: 517-522), investigated the effect of grazing intensity on rangeland in Southern Argentina, and concluded that the most important change recorded was the

transformation of the grass steppe into shrub steppe. They also found that the size of bare patches was increased, leading to an accelerated erosion process. These results agreed with Pantis and Mardiris (1992, pp: 232-242), who found that grazing increased the cover of undesirable species from 7 % to 50 %, and the total plant cover decreased from 80 % to 4 %. According to Holechek et al (1989, p.173), the selection of the correct stocking rate is the most important grazing management. Le-Houerou (1993, p.179) reported that heavy grazing decreased the number, density and cover of palatable species.

As in other Mediterranean rangelands, Palestinian rangelands have been grazed by domestic livestock, mainly sheep and goats for at least 5000 years (Noy- Meir and Seligman, 1979, p.134. Pearse, 1970, pp: 13-16).

Most of rangelands in West Bank were open to farmer before Israeli occupation. After 1967, military restrictions have reduced the total area available for grazing (ARIJ, 1994, P.130). Farmers usually start grazing when certain plants begin to appear on rangelands, and the termination of grazing depends largely on the depletion of palatable plants and lack of drinking water (Abu-Zant et al, 2003 pp:5-6). In a survey conducted by ARIJ (1994, pp: 132-134), it was clear that natural pastures in the West Bank include several important fields, such as Al-Baai'a region, Arab Al-Ta'amreh region, Arab Al-Ka'abneh region, arab Al-Rashayda, Wadi Al-Juhhar, and Wadi Sa'ir.

With the increase of the population in West Bank, the demand for animal products has grown, and subsequently the number of livestock increased (PCBS, 2003, pp: 34-42). This increase in livestock is associated with a decrease in the available rangelands, due to military restrictions and expansion of urban area and cultivated lands. As a result, rangelands resources are being put under a serious pressure of early and overgrazing, which has led to decrease in vegetation cover and productivity; increase in poisonous and unpalatable plants; severe soil erosion and ultimately to the threat of desertification in many areas (Al-Seikh, 2006, p.85. Mohammad, 2005, pp: 42-54)

The influence of grazing on rangeland vegetation has not yet been evaluated in West Bank. This research was initiated to study the effect of excluding grazing on range vegetation after a long period of severe overgrazing

Study Site

The research was conducted at Massafer Bani-Noe'm rangeland which is located at the southern part of the Eastern slopes in West Bank, at about 15 Km to the east of Hebron city. The coordinates of the site are: Latitude 31º 28', and longitude 35º 10', with 670 m elevation (GIS, 2004). The amounts of annual precipitation at the study site were 225 mm and 334 mm during the years 2004 and 2005 respectively.

The topography of the site is hilly with moderate steep slopes. The soil belongs to the soil association of Brown Lithosols and Loessial Arid Brown soil, which characterizes the eastern slopes of the West Bank (ARIJ, 1997, p.76). The site is characterized by a semi-arid climate with long hot dry summers, and moderately cool rainy winters. Precipitation comes as strong storms that last for only short period. The long term average annual rainfall is about 250-300 mm (MOA, 2004).

This area was heavily grazed by the villagers and Bedouins for a long time, which led to soil erosion and reduction of vegetation cover. The total area of the site is 50 ha. For research purpose grazing has been excluded from plots in the area since the year 1996.

Research Methodology

Vegetation cover, species diversity and plant biomass were estimated and compared between grazed and non grazed plots (fenced plots) for two seasons 2004 and 2005.

Simple random sampling method was used for quadrate allocation and Vegetation measurements were carried out in April during the peak development stage of the plants (Tedmor et al, 1974, pp: 427-433. Gutman and Seligman, 1979, pp: 86-92. Mohammad, 2007

(unpublished). Plants were identified according to Al- Eisawi, 1998. Zohary, 1966. Burnie, 1995 and Ori et al, 1999.

Vegetation cover and plant biomass were evaluated as follows:

Plant Dry Biomass

At each treatment (grazed and ungrazed plots) fifteen 1 m^2 quadrate (square plots) were randomly allocated (as replicate), and all the current year growth of each plant species inside the quadrate was clipped to the soil surface and placed in labeled paper bags except for rare species which placed in one bag for each quadrate . Fresh and dry weights (65 C°) were recorded (Bonham, 1989, p.201). A completely randomized design was used to compare between the treatments.

Plant Density

At each treatment fifteen 0.25 m^2 square quadrate were randomly allocated (as replicate). The number of all species and individual number of each species were recorded for each quadrate (Bonham, 1989, p.141).

Vegetation Cover

To measure the ground cover percentage at each plot, a one hundred point step method (Evans and Love, 1957, pp:208-113) was used at each treatment to record whatever appeared below the tip of the boot along a randomly laid transect (soil, rock, or plant by species), then the percentages of soil, rock, and plant were calculated.

Species Richness and Diversity

Species richness (s) is the number of species in certain area within a community (Barbour et al, 1987, p.162). Richness was calculated as the number of species in an area (15quadrats * 0.25 area of each quadrate), regardless of their density.

The Shannon-Weiner index was used as diversity index. The Shannon-Weiner index assumes that individuals were sampled from a very large population and that all species are represented in the sample. It was estimated as follows:

$$H' = -\sum_{i=1}^{s} (p_i \ln p_i)$$

Where s is the number of species, P*i*= is the proportion of individuals found in the *i*th species (Gurevitch et al, 2002, p. 244).

Statistical Analysis

Biomass and plant density were analyzed by using Sigma Stat 2.0 for Windows® program.

Results

Plant Biomass

Data showed a significant (p <0.05) amount of plant dry biomass was removed by livestock grazing in grazed compared to ungrazed plots during both years 2004 and 2005 (Table 1). It was found that plant dry biomass in grazed plot was 313.7 kg ha^{-1} and 559.7 kg ha^{-1} during the years 2004 and 2005 respectively, while in ungrazed plot it was 978.5 kg ha^{-1} and 2104.8 kg ha^{-1} during the years 2004 and 2005, respectively (Table 1). Comparing to the ungrazed plot, data showed that livestock utilized about 70 % of the dry biomass, despite the fact that vegetation measurements were carried out in April.

Table (1): Average plant dry biomass (kg m^{-2}) in grazed and ungrazed plots at the study site in 2004 and 2005.

Year	2004	2005
Ungrazed	978.5* ±232.7 a**	2104.8 ±350.3 a
Grazed	313.7±116.3 b	559.7±135.6 b

** Means followed by the same letters within the same column are not significantly different according to Fisher LSD Method at P ≤ 0.05.

* Mean of fifteen replicates ±SE.

During the year 2005, Shrubs have the highest dry biomass (301.3 kg ha^{-1}) in the grazed plot; despite that only two shrub species were dominant. The unpalatable semi-shrub *Sarcopoterium spinosum* has the highest dry biomass; (245 kg ha^{-1}) followed by *Thymelaea hirsute* that has dry biomass equal to 56.3 kg ha^{-1}. Total forbs dry biomass in the grazed plot was 166.1 kg ha^{-1} and varied among species. *Asphodelus aestivus* has the highest dry biomass (93.1 kg ha^{-1}). In the ungrazed plot; forbs has the highest plant dry biomass (1427.4 kg ha^{-1}), and *Asphodelus aestivus* (306.2 kg ha^{-1}) was the dominant forb followed by *Anthemis palaestina* (186.3 kg ha^{-1}) and *Ballota undulate* (169.4 kg ha^{-1}) (Table 2). Grasses dry biomass was 445.3 kg ha^{-1} in 2005 with *Poa bulbosa* has the highest dry biomass (312.9 kg ha^{-1}).

Table (2): Average plant dry biomass (kg ha^{-1}) for each species at the study site in grazed plots compared with ungrazed plots during the years 2004 and 2005.

Plant Species	**Ungrazed**		**Grazed**	
Grasses	**2004**	**2005**	**2004**	**2005**
Avena sterilis	0	2.9	0	0
Bromus fasciculatus	0	0	0	5.5
Bromu spp	7	25.1	0	0
Crithopsis delileana	0	0	0	4.7
Hordeum spontaneum	0	0	0.9	0
Lolium sp	0	0	1.5	4.4
Phalaris sp	5.5	20.1	2.9	31.2
Piptatherum miliaceum	0	42.3	0	0
Poa bulbosa	161.7	312.9	4.6	41
Stipa capensis	16.8	42	4.9	3.3
Other grasses	0.7	0	0	2.1
Total Grasses	**191.7**	**445.3**	**14.8**	**92.2**

… Continue table (2)

Plant Species	Ungrazed		Grazed	
Grasses	**2004**	**2005**	**2004**	**2005**
Forbs				
Allium stamineum	0.3	0	0	0
Anagallis arvensis	2.9	4.5	0	0
Anthemis palaestina	36.6	186.3	0	0
Arnebia tinctoria	7.4	0	0	0
Asphodelus aestivus	37.1	306.2	57	93.1
Atractylis cancellata	2.1	16.1	0	0
Ballota undulate	0	169.4	0	0
Biscutella didyma	1	0	0	0
Carlina curetum	0	0	4.7	0
Carlina hispanica	39.9	27	0	0
Carthamus tenuis	3.5	2.3	0	10.1
Centaurea sp	1.3	5.2	0	0
Cichorium pumilum	2.1	11.5	0	1.8
Crepis aspera	0	11.5	0	3.6
Dianthus strictus	0	13.6	0	0
Echinops polyceras	14.6	76.1	74.2	22.3
Erodium gruinum	74	95.5	0	0
Eryngium creticum	5.3	10.6	44.9	16.1
Euphorbia paralias	0	4.7	0	0
Evax contracta	0.5	0	0	0
Gundelia tournefortii	1.1	7.7	0	1.3
Hedypnois cretica	0	4.5	0	1.8
Helianthemum salicifolium	5.9	13.1	0	0
Lactuca orientalis	0.7	0	0	0
Lactuca spp	0.7	0	0	0
Lathyrus cicera	13.1	2.1	0	0
Lomelosia palaestina	22.3	26.2	0	0
Malabaila secaul	0.3	17.3	0	0

… Continue table (2)

Plant Species	**Ungrazed**		**Grazed**	
Grasses	**2004**	**2005**	**2004**	**2005**
Medicago sp	8.1	41.1	0	0
Minuartia decipiens	0	0	0	0
Notobasis syriaca	4.1	10.3	0	0
Ononis sicula	0	31.7	0	0
Ononis sp	0	11.5	0	0
Onobrychis caput-galli	2.5	61.8	0	0
Onopordon alexandrium	28.7	0	0	
Pallenis spinosa	0	27.6	0	0
Plantago afra	0	0	0	1.8
Salvia palestinea	0	55.6	0	0
Scorzonera schweinfurthii	7	0	0	0
Sinapis arvensis	2.5	0	0	0
Sonchus oleraceus	0	2.9	0	0
Tragopogon porrifolius	1.7	6.8	0	0
Trigonella stellata	0	8.3	0	0
Trifolium stellatum	1.8	7.1	0	0
Trifolium spp	0	0.3	0	0
Torilis tenella	10.6	7.4	0	0
Urginea maritima	0.5	0	3.4	5.3
Vicia sp	0	11.3	0	0
Other forbs	21	132.3	3.6	8.9
Total Forbs	**361.2**	**1427.4**	**187.8**	**166.1**
Shrubs				
Astragalus spinosus	82.8	0	0	0
Phagnalon rupestre	0	9.3	0	0
Sarcopoterium spinosum	0	143.2	61.1	245
Scrophularia xanthoglossa	122	49.1	0	0
Thymelaea hirsute	220.8	30.5	50.1	56.3
Total Shrubs	**425.6**	**232.1**	**111.2**	**301.3**

Ground Cover

Vegetation cover percentage forms 68% of ground cover in the grazed plot at the study site in the year 2005, whereas in the ungrazed plot it forms 93% of ground cover (Table 3). By taking the ground cover percentage of grasses, forbs and shrubs, it was found that grazing decreased forbs percentage (64 % at the ungrazed plot versus 24 % at the grazed plot in 2004, and 67 % at the ungrazed versus 38 % at the grazed plot in 2005) (Table 3). Despite the fact that *Poa bulbosa* is a palatable species, our results showed that it has the highest percentage cover (13%) at the grazed plot during year 2005. The cover percentage of other unpalatable species increased at the grazed plot compared to ungrazed plot. Some of those species are: *Asphodelus aestivus* and *Sarcopoterium spinosum* (Table 3).

Table (3): Ground Cover Percentage (%) (Plant, soil, and rock) in grazed plots compared with ungrazed plots at the study site during the years 2004 and 2005

Items	**ungrazed**		**Grazed**	
Grasses	**2004**	**2005**	**2004**	**2005**
Avena sterilis	1	0	0	1
Bromus fasciculatus	0	1	0	0
Bromuse tectorum	0	2	0	0
Bromu sp	1	0	0	0
Phalaris sp	2	3	8	8
Poa bulbosa	18	18	3	13
Poa sp	3	0	9	0
Total Grasses	**25**	**24**	**20**	**22**
Forbs				
Allium stamineum	1	0	1	0
Anagallis arvensis	0	2	0	0
Anthemis palaestina	11	7	2	0
Asphodelus aestivus	2	0	11	5
Biscutella didyma	1	0	0	0

… Continue table (3)

Items	ungrazed		Grazed	
Grasses	**2004**	**2005**	**2004**	**2005**
Carlina hispanica	1	1	0	0
Carthamus tenuis	0	0	0	3
Centaurea sp	1	3	1	1
Cichorium pumilum	0	2	2	6
Crepis aspera	1	5	0	2
Crithopsis delileana	0	0	0	1
Echinops polyceras	4	4	2	8
Eroduim acaule	0	1	0	0
Erodium gruinum	9	11	0	0
Euphorbia sp	0	0	0	1
Eryngium creticum	1	2	4	3
Eryngium sp	3	1	0	0
Gundelia tournefortii	0	2	1	0
Helianthemum salicifolium	1	0	0	0
Heliotropium europoeum	1	1	0	0
Lactuca orientalis	1	1	0	0
Lomelosia palaestina	7	4	0	0
Lolium sp	0	0	0	1
Malabaila secaul	0	1	0	1
Medicago sp	3	0	0	0
Notobasis syriaca	3	1	0	0
Ononis sp	0	2	0	0
Onobrychis caput-galli	2	3	0	1
Salvia sp	3	0	0	1
Tetragonolobus palaestinus	1	0	0	0
Tragopogon porrifolius	2	1	0	0
Trigonella stellata	0	1	0	2
Trifolium campestre	0	1	0	0
Trifolium resupinatum	0	2	0	0

… Continue table (3)

Items	ungrazed		Grazed	
Grasses	**2004**	**2005**	**2004**	**2005**
Trifolium stellatum	2	3	0	1
Torilis tenella	1	4	0	0
Urginea maritima	0	0	0	1
Other forbs	2	1	0	0
Total Forbs	**64**	**67**	**24**	**38**
Shrubs				
Astragalus spinosus	1	0	0	0
Sarcopoterium spinosum	1	0	7	5
Scrophularia xanthoglossa	1	1	0	0
Thymelaea hirsute	2	1	3	3
Total Shrubs	**5**	**2**	**10**	**8**
Plant Total	**94**	**93**	**54**	**68**
Rock	**3**	**4**	**19**	**16**
Soil	**2**	**3**	**27**	**16**

Plant Density

Excluding grazing had significantly (p <0.05) increased plant density five times and two times during the years 2004 and 2005, respectively (Table 4). It was found that plant density in grazed plots were 103.2 plants m^{-2} and 194.4 plants m^{-2} during the years 2004 and 2005, respectively, while in ungrazed plots, the plant density were 645.9 plants m^{-2} and 518.9 plants m^{-2} during the same years.

Table (4): Average plant density (plants m^{-2}) in grazed and ungrazed plots at the study site during the years 2004 and 2005.

Year	2004	2005
ungrazed	645.9* ±127.2 a**	518.9 ±85.6 a
Grazed	103.2 ±25.6 b	194.4 ±20.6 b

** Means followed by the same letters within the same column are not significantly different according to Fisher LSD Method at $P \leq 0.05$.

* Mean of fifteen replicates ±SE.

By taking the plant density of grasses, forbs and shrubs in the year 2005, data showed that excluded grazing increased grass density (144.6 plants m^{-2} in the grazed plot versus 316.7 plants m^{-2} in the ungrazed plot); while total shrubs density nearly were not changed (Table 5).

Plant density of some species was increased at the grazed plot compared to the ungrazed plot. Among these species were: *Sarcopoterium spinosum*, *Asphodelus aestivus*, *Lolium sp*, *Cichorium pumilum*, *Eryngium creticum*, *Trigonella stallatum*, *Evax contracta*, *Hordeum spontaneum*, and *Plantago afra* (Table 5). On the other hand, other species were increased in the ungrazed plot such as: *Avena sterilis*, *Poa bulbosa*, *Bromus tectorum*, *Anthemis palaestina*, *Biscutella didyma*, *Trifolium stellata*, *Helianthemum salicifolium, Onobrychis caput-galli*, *Ononis sicula*, *Anagallis arvensis* and *Atractylis cancellata* (Table 5), all these species are annual except *Poa bulbosa*.

Table (5): Average plant density (plants m^{-2}) for each species at the study Site in grazing plots compared with ungrazed plots during the years 2004 and 2005

Plant Species	**Ungrazed**		**Grazed**	
Grasses	**2004**	**2005**	**2004**	**2005**
Aeglibose spp	0	0	0	0.8
Avena sterilis	0	0.8	0	0.3
Bromus fasciculatus	0	1.1	0	5.9
Bromus lanceolatus	0	0.3	0	0
Bromuse tectorum	0	0.5	0	0
Bromu sp	12.5	1.9	0	1.1
Crithopsis delileana	0	0.3	0	5.3
Hordeum spontaneum	0	0	2.1	0.3
Lolium sp	0	0	10.1	8.5
Phalaris sp	27.2	54.7	20.3	44.3
Piptatherum miliaceum	0	0.3	0	0
Poa bulbosa	408	247.7	22.7	75.7
Stipa capensis	41.3	9.1	23.2	2.4
Total Grasses	**489**	**316.7**	**78.4**	**144.6**
Forbs				
Allium stamineum	0.3	0.3	0	0
Anagallis arvensis	3.7	7.2	0.3	0.3
Anthemis palaestina	49.9	76.5	0	0
Arnebia tinctoria	0.3	0	0	0
Asphodelus aestivus	2.1	5.1	6.7	3.7
Atractylis cancellata	1.6	6.4	0	0.5
Ballota undulate	0	0.3	0	0
Biscutella didyma	1.1	1.1	0	0.3

… Continue table (5)

Plant Species	Ungrazed		Grazed	
Grasses	**2004**	**2005**	**2004**	**2005**
Carlina curetum	0	0	0.3	0
Carlina hispanica	0	0.5	0	0
Carthamus tenuis	0.5	2.7	0	1.3
Centaurea sp	1.3	1.3	0	0
Cerastium inflatum	0	0	0	1.9
Cichorium pumilum	0.5	1.1	1.1	3.7
Crepis aspera	0	4	0	2.9
Echinops polyceras	0.5	1.1	1.1	0.5
Eroduim acaule	0	0.3	0	0
Erodium gruinum	13.3	12.5	0	0
Eryngium creticum	0	0	1.3	1.1
Euphorbia paralias	0	1.9	0	0
Euphorbia sp	0	0.3	0	0
Evax contracta	1.9	0	11.7	6.7
Gundelia tournefortii	0	0.8	0	0
Gynandriris sisyrinchium	0	0.5	0	0.3
Hedypnois cretica	0	0.3	0	0.3
Helianthemum salicifolium	0	14.7	0	0.8
Lactuca spp	0.8	0	0	0
Lagoecia cuminoides	0	0.3	0	0.3
Lathyrus cicera	13.9	0.5	0	0
Lomelosia palaestina	13.6	13.9	0.5	0
Malabaila secaul	6.9	1.3	0	0
Medicago sp	1.9	5.9	0.3	0

… Continue table (5)

Plant Species	**Ungrazed**		**Grazed**	
Grasses	**2004**	**2005**	**2004**	**2005**
Minuartia decipiens	0	0	0	2.4
Notobasis syriaca	0.3	0.5	0	0
Ononis sicula	0	6.7	0	0.8
Ononis sp	0	2.4	0	0
Onobrychis caput-galli	1.3	5.6	0.5	0.3
Pallenis spinosa	0	0.2	0	0
Paronychia argentea	0	0.2	0	0
Plantago afra	0	0	0	2.1
Plantago cylindrical	0	0.5	0	0
Rhagadiolus stellatus	0	0.2	0	0
Salvia palestinea	0	0.2	0	0
Scandix pectin-veneris	0	0.2	0	0
Sinapis arvensis	0.5	0	0	0
Tragopogon porrifolius	0.5	0.5	0	0
Trigonella stellata	0	8	0	12.8
Trifolium stellatum	0.3	2.7	0	0.3
Trifolium spp	0	0	0	0.5
Torilis tenella	14.1	3.5	0	0.5
Urginea maritima	0	0	0.3	0
Vicia sp	0	8.8	0	0
Other forbs	2.7	0.8	0	3.9
Total Forbs	**133.8**	**201.8**	**24.1**	**48.2**

… Continue table (5)

Plant Species	Ungrazed		Grazed	
Grasses	**2004**	**2005**	**2004**	**2005**
Shrubs				
Astragalus spinosus	0.3	0	0	0
Sarcopoterium spinosum	0	0.3	0.3	1.6
Scrophularia xanthoglossa	0.5	0.3	0	0
Thymelaea hirsute	0.3	0	0.5	0
Total Shrubs	**1.1**	**0.6**	**0.8**	**1.6**

It was noticed that in the grazed plots the highly palatable species (Ice cream plants) were utilized early in grazing season, therefore, they were only found in the ungrazed plot, among these species are: *Elymus sp*, *medicago spp*, *Erodium gruinum* and *Vicia sp*.

Plant Diversity

Grazing decreased the species richness. Plant species richness at the grazed plot was 35 species per 3.75 m^2, whereas it was 54 species per 3.75 m^2 at the ungrazed plot in the year 2005. Using Shannon-Weiner index, it was found that ungrazed plot was more diverse (1.2) than grazed plot (0.95) in the year 2005.

Discussion

Plant Biomass

Data in table (1) showed that there was lack of correlation between precipitation and plant dry biomass during the years 2004 and 2005. This might be due to variation in the climatic factors specially the amount and the distribution of rainfall. Similar results were observed by Mohammad (2000, pp: 75-87) at Southern part of the West Bank, who concluded that the distribution of the precipitation in growing season and soil characteristics determine range land productivity.

Le Houro (1977, pp: 181-189) found that rainfall is the most important climatic factor affecting natural pasture production, and it is correlated with a number of other climatic factors such as rain variability, number of rainy days, length dry and rainy seasons, and potential evapotranspiration.

Results of table (1) showed that dry biomass at the peak of the season in the ungrazed plot was significantly higher than that in the grazed plots. This was attributed to severe defoliation caused by the early heavy grazing of the grazing ruminants which caused defoliated plants to loose the photosynthetic tissues and exhibit a decreased growth rate. This result is expected since early heavy grazing was the prevailing grazing system at the study area. It is also important to note that the proportion of the utilized dry biomass increase in the summer season due to continuous grazing and the utilization of less preferred species. O'regain et al (1995, pp:314-341) found that only after 80 - 100% of the tillers of the preferred and less preferred species had been defoliated; grazing of the previously avoided species is initiated. The decrease in the palatable and less palatable species reduced the competition with other species; therefore increased growth of the unpalatable species, and invaders species displaced the palatable species. This explains the high relative dry biomass of unpalatable species in grazed plot like *Sarcopoterium spinosum* and *Asphodelus aestivus*.

Utilization of palatable species early in the growing season within about two months only, usually forced the farmers to offer commercial feeds to their livestock during the rest of the year.

Selection of suitable grazing management might increase the dry biomass in grazing areas. This assumption was discussed by several researchers(Holechek et al, 1989,p.129. Mazancourt and Loreau, 2000, pp: 81-92. Mazancourt, 1998. Mc-Naughton, 1979, pp:691-703) as The Grazing Optimization Hypothesis which states that:" *Primary production can be increased with low grazing intensity and reach an optimum at intermediate grazing, before production decreases again when grazing intensity becomes too high"*. According to Vallentine (1990, p.390) moderate continuous grazing has been identified as the most ecologically

and economically sustainable grazing management practice for domestic livestock on rangelands. This is consistent with Le-Houerou (1993, p. 192) who concluded that reduced intensity of grazing offers the only practical means of range improvement in Mediterranean rangelands. Therefore further researches are highly needed to investigate the suitable grazing management in the West Bank rangeland.

Plant Density

The study site was subjected to early and heavy grazing; where the plants have no chance to grow or reproduce. Therefore, the decrease in plant density at grazed plots and the increase in plant density, mainly the annuals, at excluding grazing plots might be due to either the consumption of plants by livestock, or the damage of small plants by trampling. Such factors depend on grazing period and grazing intensity (Holechek et al, 1989, pp: 115-118).

The other possibility could be due to the effect of livestock on the seed bank because livestock graze vegetation in spring when most of the plant species are flowering or producing seeds; since annuals need to set seed year after year to maintain themselves. Seed banks in the Mediterrian grasslands following a long period of uncontrolled grazing were studied by Abu-Zanat et al (1998, pp: 195-202), and they found that the number of plant species in the soil seed banks was low. This agrees with Al-Shawaheneh et al (1998, pp:380-391) who concluded that uncontrolled grazing of rangelands had a negative impact on the seed production and seed survival of the existing plants which results in a very small size of seed banks.

The presence of palatable species with moderate density in grazing plots might be due to their defenses strategy as these species seems to be adapted to resist grazing. Strernberge et al (2000, pp:224-237) concluded that hemicryptophytic species such as *Hordeum bulbosum* were adapted to survive under heavy and very heavy grazing pressure, as their perennating buds are buried near the soil surface and most of their shoots desiccate in summer. On the other hand, it was noticed that some of the palatable species were hidden under unpalatable shrubs as *Sarcopoterium*

spinosum, or between rocks. This agrees with Le-Houerou (1993, p179) who reported that best forage survives under heavy grazing only in ecological niches where some protection from overgrazing exists by rugged land surface and by spiny shrubs.

Increasing species richness is probably due to the fact that excluding grazing gives chance for new species to appear. This might indicate that these rangelands have the potential to rehabilitate if suitable management is used. This agrees with Al-Seikh (2006, p.95) where the researcher found that the soil moisture increased significantly when grazing was excluded at the same site.

Botanical Composition

Unpalatable species such as *Sarcopoterium spinosum*, *Asphodelus aestivus*, *Echinops polyceras*, and *Eryngium creticum* were the dominant species in the grazed plot. This would mostly be due to heavy and selective grazing on palatable species (*Medicago spp*, *Bromus spp*, *Hordeum spp*, *Aegilops spp*, *Poa bulbosa* and *Avena sterilis*). such palatable species, mostly annuals, can be considered as decreasers as it was noticed that some of them colonize in specific microhabitats especially under shrubs as *Sarcopoterium spinosum* in the grazed plot.

The decrease in palatable species and the increase in unpalatable species were investigated by Pearse (1970, pp:13-16) who reported that the steppic and sub-steppic vegetation in the Middle East has changed from a mixture of palatable grasses, Legumes, and other good forage plants to low value annuals, thistles, and wrathless weeds, due to uncontrolled grazing. However, Noy-Meir et al (1989, pp: 290-310) found that the response of Mediterranean grassland to protection and grazing is more divers than could be expressed by an increasers-decreasers classification.

The decrease of forbs in the grazed plot might be due to two reasons: first they are preferred more than grasses due to their broad, tall leaves and high leaf: stem ratio (Vallentine, 1990, p.185). It is well known that sheep prefer forbs; therefore excluded grazing could give more chances

to forbs to re-grow. Secondly, due to their reproduction methods as forbs depend mainly on producing large number of seeds. Livestock graze vegetation in spring when most of the plant species are flowering or producing seeds; grasses largely reproduce by buds and rhizomes that are buried under soil surface and re-grow when grazing is excluded.

The disappearance of some shrubs in grazed plot, might be due to the random sampling method that was used, as in this method, the location of the transect different each year, and the very rare species might not appear or recorded.

Conclusion

Under present conditions; early and severe overgrazing induced vegetation retrogression that is expressed in decreasing plant density, and biomass and an increase in unpalatable plant species, thus reducing the length of grazing period for about two months only. Therefore, to have clear picture of response of species to grazing and protection at the West Bank rangelands, long-term studies are necessary to understand species persistence in these rangelands. These studies will be useful in future management recommendations for conservation and sustainable development for livestock production. And further studies are needed to investigate the suitable grazing management in these areas.

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