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Effect of Grazing Season on the Productivity Parameters of Five Range Shrubs

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ABSTRACT. Five forage shrubs were defoliated in different seasons in order to estimate the foliage productivity and current year growth. Shrubs under study were *Atriplex halimus, A. nummularia, A. canscens, A. polycarba*, and *Salsola vermiculata*. Investigated parameters were green foliage weight (GFW), dry foliage weight (DFW), green current year growth (GCYG), and dry current year growth (DCYG).

Productivity estimates observed in spring (702 kg/ha dry matter) and summer (725 kg/ha) were significantly higher than those in autumn (518 kg/ha) and winter (527 kg/ha). There were significant differences between productivity of different shrub species for all investigated parameters through all seasons except for GFW and DCYG in summer and winter, and for DCYG in summer, in the first year. Productivity trends showed that *A. nummularia* (770 kg/ha dry matter) had nearly the highest yield followed by *A. halims* (716 kg/ha), *A. canscens* (671 kg/ha), *S. vermiculata* (500 kg/ha), and *A. polycarba* (437 kg/ha), respectively, in a decreasing order.

Browsing of these forage shrubs almost depends upon the range condition in which these shrubs were planted. Livestock could start browsing foliage shrubs in spring when the range condition is poor, in summer when range condition is fair and in autumn and winter when range condition is good.

Shrub species are major components of arid and semi-arid range-lands throughout the world and are important sources of forage (browse) for domestic and wild herbivores (Ruyle *et al.* 1983). Range production in arid and semi-arid lands differ greatly from one season to another (Stoddart *et al.* 1975). Maximum and minimum productions are gained in spring and autumn, respectively, due to the flowerishing of annuals in the spring. One of the strategies for range improvement is to narrow the gap between the lowest and the highest productivity levels around the year. This could be achieved only by increasing the percentage of fodder shrubs through the range (Tag El Din 1983). Fodder shrubs could be increased either by distributing stands of these shrubsa within the range area or by cultivating them under irrigation as a complementary fodder in reserved areas. Wilson (1969) revealed that browse is often considered important only during winter grazing periods or in low rainfall areas as a reserve feed in times of drought.

Forage production varies within and among species, with age of plants, with season of the year, and among years (Bartolome *et al.* 1982). Forage nutritive quality on most ranges varies tremendously between seasons, (Holechik *et al.* 1989). Levels of cell soluble crude protein, and phosphorus are the highest in actively growing forages and show substantial declines as plant becomes dormant (Parker 1969). Great differences of diet nutritional quality within and between range types occur with seasonal change (Rosiere and Torell 1985, Cook *et al.* 1967, and Buchanan *et al.* 1972). This is because the timing and length of the growing season is often related to climatic differences. Digestability values for sheep during active forage growth are generally over 50%. During the dormant period, livestock diets in most ranges, have digestability values lower than 50%.

In arid regions, most of irrigation water is characterized as saline. Shrubs of *Atriplex* could be grown successfully with saline water irrigation. In addition, they are also drought tolerant. Many Arab countries utilize *Atriplex* in range improvement projects. The aims of this study are, 1) to estimate the foliage production and current year growth of five forage shrubs in different seasons of the year, and, 2) correlate the production parameters with range condition.

Materials and Methods

This study was conducted in the Ghatghat Research Station of the Center of Desert Studies, King Saud University, 50 km west of Riyadh. The climate is subtropical hyper arid type. Average annual precipitation totals about 100 mm. The soil belongs to Torripsamments soils and is characterized by having a deep profile and a sandy to sandy loam texture, calcareous; very low in organic matter content, alkaline in reaction with electrical conductivity ranging from 0.8 to 3.8 m.mohs, and a gypsum content ranging from 2.7 to 3.5%.

The species evaluated in the study were *Atriplex halimus* L., *A. nummularia* Lindly, *A. canescens* James, *A. polycarpa* L. Wats and *Salsola vermiculata* L., whereas the design used was a split plot with three replications.

Six months shrub seedlings were transplanted through the last week of March of both years1988 and 1989. In executing the trial, plants were spaced 2 meter apart from each other and were irrigated with artesian water (salinity about 5000 ppm) monthly in summer and every two months in winter. In this design, defoliation times, *i.e.* last weeks of March, June, September and December, representing spring, summer, autumn and winter seasons, respectively, were assigned to the main plots, whereas plant species were assigned to the subplots. Each subplot consisted of eight shrubs, four of which were randomly assigned to measure green foliage weight (GFW) and dry foliage weight (DFW) accumulated during the current and previous years; whereas the other four shrubs were used to measure green current year growth (GCYG) and dry current year growth (DCYG).

Defoliation practices were applied through 1990 for shrubs cultivated in 1988 and through 1991 for those cultivated in 1989. GFW was obtained by weighing all the fresh green shoots and leaves defoliated from the shrub. A sample was oven dried at 105°C for 24 hours to estimate DFW. GCYG was determined by defoliating and weighing the fresh new year current growth, which nearly represent the allowable green foliage for grazing. Also, a sample was oven dried at 105°C for 24 hours to determine DCYG.

The data collected was analyzed as a split-plot design combined over the two years.Appropriate standard errors were calculated and attached to the different mean values (Steel and Torrie, 1981).

Results and Discussion

The significant influence of defoliation season and shrub species on productivity parameters (GFW, DFW, GCYG, DCYG) in two years are presented in Table 1. Productivity parameters varied among species for the different seasons in different years.

Table 1. Productivity parameters as influenced by season of defoliation and species

Source	d.f.	Green foliage weight	Dry foliage weight	Green current growth	Dry current growth
Years (Y)	1	N.S	*	N.S	*
Seasons (S)	3	**	**	**	**
Y × S	3	N.S.	**	N.S.	**
Species (Sp)	4	**	**	**	**
Sp × Y	4	N.S.	N.S.	N.S.	*
Sp × S	12	**	**	**	**
Sp × Y × S	12	*	**	**	**

N.S. Not significant, $p < 0.05$.
* Significant, $p < 0.05$ or less.
** Significant, $p < 0.01$ or less.

Green Foliage Weight (GFW)

Green foliage weight represents the fresh weight of leaves and edible shoots of the whole plant accumulated during the previous years and the current year. Table 2 shows means of GFW as affected by both the season of defoliation and the plant species for each two years as well as for the combined analyses over the two years.

Table 2. Green foliage weight (GFW) of shrubs in different seasons (kg/ha)

Spp. / Season	First year						2 Years average
	A. halimus	*A. nummula.*	*A. canscens*	*A. polycar.*	*S. vermic.*	Mean	
Spring	1733 AB	2246 a A	1944 a A	702 C	1166 BC	1566 a	
Summer	1755 AB	2003 a A	1292 b BC	792 C	1008 C	1368 a	
Autumn	1445 A	986 b AB	626 c B	486 B	815 B	873 b	
Winter	1472 A	1445 b A	932 bc AB	657 B	693 B	1031 b	
Mean	1590 A	1670 A	1211 B	662 C	923 BC	1211	
Second year							
Spring	1908 a A	1724 A	1418 AB	923 BC	738 C	1341 a	1454 a
Summer	1742 a A	1836 A	1323 C	693 B	428 B	1211 ab	1287 a
Autumn	1193 b AB	1454 A	1008 ABC	819 BC	576 C	1008 bc	914 b
Winter	1112 b AB	1530 A	936 BC	495 C	662 BC	945 c	990 b
Mean	1485 A	1643 A	1170 B	734 C	603 C	1125	
2 Years average	1539 A	1656 A	1188 B	698 C	761 C		1170

Means in each column with the same small letters are not significantly different at 0.01 level.
Means in each row with the same capital letters are not significantly different at 0.01 level.

It is evident from the data that overall foliage weights being 1211 kg/ha in the first year and 1125 kg/ha in the second were not significantly different from each other. The interaction between years and seasons was also not significant. Except in autumn, GFW for all seasons in the first year were generally higher than those of the second year. In autumn, average yield in the second year (1008 kg/ha) was higher than that of the first (873 kg/ha). Cutting season significantly affects GFW in each two years as well as over the two years. Spring and summer GFW means in the first year and over the two years were significantly higher than those for autumn and winter. In the second year, the trend was statistically the same except the summer yield (1211 kg/ha) was not significantly higher than the autumn yield (1008 kg/ha).

The differences between seasons in GFW for the different plant species were non-significant for both years except for *A. nummularia* and *A. canscens* in the first year and for *A. halimus* in the second. Generally, highest GFW means for most species were obtained in spring followed by summer, autumn and winter, respectively.

The interaction between years and species was statistically non-significant. There were significant differences between species in GFW for each of the two years and over the two years in all seasons. Generally, *A. nummularia* had the highest GFW followed by *A. halimus, A. canscens, S. vermiculata* and *A. polycarpa*, respectively. The differences between *A. nummularia*, and *A. halimus* and between *A. polycarpa* and *S. vermiculata*, were statistically non-significant.

Dry Foliage Weight (DFW)

Dry foliage weight (DFW) represents the dry weight of leaves and edible shoots of the whole plant accumulated during the previous years and the current year. Table 3 shows that DFW in the first year (657 kg/ha) was significantly higher than that of the second year (581 kg/ha). The combined analysis showed that DFW recorded in spring and summer were significantly higher than those for autumn and winter, either in the first year or over the two years. In the second year, DFW in summer (680 kg/ha) was significantly higher than that in the spring (549 kg/ha).

Table 3. Dry foliage weight (DFW) of shrubs in different seasons (kg/ha)

Spp. / Season	First Year						2 Years average
	A. halimus	*A. nummula.*	*A. canscens*	*A. polycar.*	*S. vermic.*	**Mean**	
Spring	752 BC	1170 a A	1080 a AB	518 C	765 BC	860 a	
Summer	914	914 ab	644 b	585	797	770 a	
Autumn	621	477 c	365 b	320	576	473 b	
Winter	545	653 bc	540 b	414	500	531 b	
Mean	707 AB	806 A	662 A	459 C	657 BC	657	
Second year							
Spring	671 A	626 b AB	702 ab A	405 BC	333 C	549 b	702 a
Summer	864 A	932 a A	932 a A	396 B	284 B	680 a	725 a
Autumn	752 A	752 ab A	513 b AB	504 AB	315 B	567 ab	518 b
Winter	508 A	644 b A	572 b A	342 B	441 AB	522 b	527 b
Mean	725 A	738 A	680 A	410 B	311 B	581	
2 Years average	716 A	770 A	671 A	437 B	500 B		617

Means in each column with the same small letters are not significantly different at 0.01 level.
Means in each row with the same capital letters are not significantly different at 0.01 level.

The interaction between years and seasons was highly significant. In the first year, spring had the highest DFW (860 kg/ha), whereas autumn had the lowest (473 kg/ha). In the second year, summer had the highest mean (680 kg/ha) and the winter had the lowest (522 kg/ha).

DFW for different plant species in different years showed that there were no significant differences between seasons, except for *A. nummularia* and *A. canscens* either in the first or in the second year.

The interaction between years and species was non-significant. The trend of species in DFW was nearly the same for the two years. In the first year, *S. vermiculata* (657 kg/ha) had higher DFW than *A. polycarpa* (549 kg/ha); while the reverse was observed in the second year. With respect to the two years average, the mean yields of *A. nummularia, A. halimus*, and *A. canscens* were significantly higher than those of *S. vermiculta* and

A. polycarpa. In the first year, *S. vermiculata* had higher dry yield than *A. polycarpa* and nearly the same yield as *A. canscens*. This might be due to the rapid growth of *S. vermiculata* compared to the other species at early years before it began to decline. In the first year, there were no significant differences in DFW values between species within the same season except for that in spring, however, significant differences between species, in all seasons, were observed in the second year.

Green Current Year Growth (GCYG)

GCYG refers to the current year growth, which could be considered as allowable foliage to be grazed. Table 4 shows that the average GCYG of the first year (648 kg/ha) was non-significantly higher than that of the second year (606 kg/ha).

Table 4. Green current year growth (GCYG) of shrubs in different seasons (kg/ha)

Spp. / Season	First year						2 Years average
	A. halimus	*A. nummula.*	*A. canscens*	*A. polycar.*	*S. vermic.*	Mean	
Spring	945 A	1224 a A	1020 a A	372 B	600 B	834 a	
Summer	870 AB	1140 a A	702 b B	408 C	576 BC	738 a	
Autumn	720 A	570 b AB	354 c BC	252 C	444 ABC	468 b	
Winter	756 AB	828 b A	480 bc BC	330 C	366 C	552 b	
Mean	828 A	942 A	736 B	342 C	498 C	648	
	Second year						
Spring	1056 a A	966 AB	732 B	486 C	396 C	726 a	780 a
Summer	954 a A	966 A	696 B	354 C	234 C	642 ab	690 a
Autumn	660 b AB	792 A	540 BC	426 C	318 C	546 bc	510 b
Winter	600 b B	828 A	504 BC	264 D	354 CD	516 c	534 b
Mean	816 A	888 A	624 B	384 C	324 C	606	
2 years average	822 B	912 A	630 C	486 D	408 D		630

Means in each column with the same small letters are not significantly different at 0.01 level.
Means in each row with the same capital letters are not significantly different at 0.01 level.

The interaction between years and seasons was non-significant. Mean values of GCYG in the spring and summer for the first year and that over the two years were significantly higher than those for autumn and winter. In the second year, GCYG values recorded in summer (642 kg/ha) was not significantly higher than that recorded in autumn (546 kg/ha).

Within plant species, there were no significant differences between GCYG values of different seasons except for *A. nummularia* and *A. canscens* in the first year and *A. halimus* in the second year. Generally, GCYG means for all species were higher in spring and summer than in autumn and winter in each of the two years. Stoddart *et al.* (1975)

mentioned that range production in arid and semi-arid lands differs greatly from one season to another.

The interaction between years and species was also non-significant. For the average values over the two years, it could be noticed that GCYG of *A. nummularia* (912 kg/ha) was significantly the highest followed by that for *A. halimus* (822 kg/ha), *A. canscens* (630 kg/ha), *A. polycarpa* (486 kg/ha) and *S. vermiculata* (408 kg/ha), respectively. The same trend was achieved for means of each year, except for GCYG of *S. vermiculata* (491 kg/ha) of the first year which was higher than that for *A. polycarpa* (342 kg/ha). Generally, the same trend was observed between species for every season in each year.

Dry Current Year Growth (DCYG)

DCYG refers to the current year growth dried at 60°c, which could be taken as allowable dry foliage to be grazed. From Table 5 the DCYG record of the first year (351 kg/ha) was significantly higher than that of the second (312 kg/ha). The data in Table 5 shows that DCYG obtained in summer (388 kg/ha) was not significantly different from that recorded in the spring (372 kg/ha) and they were both significantly higher than those for autumn (282 kg/ha) and winter (283 kg/ha).

Table 5. Dry current year growth (DCYG) of shrubs in different seasons (kg/ha)

Season \ Spp.	***First year***						**2 Years average**
	A. halimus	***A. nummula.***	***A. canscens***	***A. polycar.***	***S. vermic.***	**Mean**	
Spring	408 ab BC	618 a A	546 a AB	270 C	402 ab BC	450 a	
Summer	462 a AB	504 ab A	372 b AB	300 B	438 a AB	414 a	
Autumn	312 ab	282 c	204 c	168	316 ab	256 b	
Winter	288 b	366 bc	288 bc	204	258 b	281 b	
Mean	368 AB	444 A	352 B	234 C	354 B	351	
Second year							
Spring	364 ab A	352 b A	366 b A	216 B	172 B	294 b	372 a
Summer	472 a A	490 a A	490 a A	202 B	152 B	362 a	388 a
Autumn	420 ab A	402 ab A	276 b B	264 BC	172 C	308 b	282 b
Winter	326 b B	354 b A	322 b AB	184 C	238 BC	284 b	283 b
Mean	396 A	400 A	364 A	216 B	184 B	312	
Two years average	382 A	422 A	358 A	227 B	268 B		332

Means in each column with the same small letters are not significantly different at 0.01 level.
Means in each row with the same capital letters are not significantly different at 0.01 level.

The interaction between years and seasons was highly significant. In the first year average DCYG in the spring (450 kg/ha) was not significantly higher than that for summer (414 kg/ha), while in the second year, the summer production (362 kg/ha) was significantly higher than that of the spring (294 kg/ha). The rank of other seasons, showed nearly the same trend as that observed in the values obtained over the two years of the study. Mean values of DCYG for the different species in different years (Table 5) showed significant differences between seasons, except for *A. polycarpa* in the first year and *A. polycarpa* & *S. vermiculata* in the second year.

The interaction between years and species was only significant at 5% level. *A. nummularia* had the highest dry production in both years (444 and 440 kg/ha), while *A. polycarpa* had the lowest (234 kg/ha) in the first year and *S. vermiculata* (184 kg/ha) in the second. For different seasons in different years, DCYG values differed significantly between species, except those for autumn and winter in the first year.

Most of the studied species are characterized by their sufficient growth under arid climate with supplemental saline water irrigation. Data in Tables 2-5 showed that green matter production (total or allowable) in spring was not significantly higher than that in summer, while the reverse has obtained for dry matter production. This reverse trend may be due to the higher moisture content of plants in spring (51%) than in summer (43%). Forage production was reported to vary with season of the year, and among years, (Bartolome and Kosco 1982).

Tables 2-5 showed that the productivity averages over years in spring and summer were significantly higher than in autumn and winter. Although, productivity of dry matter is higher in spring, browsing season of these shrubs depends upon some factors. Of these, the most important one is the range condition. In this respect, if the range condition is very poor or if the livestock depends only on the cultivated shrubs, animals could start browsing in spring and summer. If the range condition varies from poor to fair, livestock could utilize the range annuals through the spring and start browsing cultivated shrubs in summer and autumn.

When range lands have sufficient native shrubs and their condition vary from fair to good, livestock could utilize annuals through spring season and early summer and then browse native shrubs through summer and early autumn. Cultivated shrubs could then be browsed in autumn and winter, although their productivity is lower than that in the spring and summer. Wilson (1969) indicated that browsing is often considered important only during winter grazing periods or in low rainfall areas as a reserve feed in times of drought.

Tables 2-5 show significant differences between species for all investigated parameters through all seasons except for dry matter productivity in autumn and winter seasons and current dry matter in summer, of the first year. The trend of productivity showed that *A. nummularia* had nearly the highest yield followed by *A. halimus, A. canscens, S. vermiculata* and *A. polycarpa*, respectively. Bartolome and Kosco (1982) also found that forage production varies within and among species.

Green and dry matter productivity are not the only parameters taken in consideration when recommending cultivating and utilizing shrubs, but other parameters *e.g.* relative palatability, adaptation, soil conservation, plant composition... etc. should be considered. Forage nutritive quality and plant composition varies tremendously between seasons, (Holechek *et al.* 1989, Parker 1969, Rosiere *et al.* 1985, and Cook *et al.* 1967). Although, *S. vermiculata* and *A. polycarpa* had low green and dry matter productivity, their relative palatability is higher than that of the other three species included in the study. *S. vermiculata* is a local shrub with high adaptation, but unfortunately disappeared from many sites in the region due to its high relative palatibility. *A. halimus* and *A. nummularia*, which have low relative palatibility, promote soil conservation. For these reasons, cultivation of most of these shrubs is recommended. This is likely to improve performance of livestock and help in soil conservation.

References

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

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.E. 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:** 1169-1174.

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

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

Rosiere, R.E. 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 (*Symphoricarpos oreophilus*) utilization by sheep from twig diameter-weight relations. *J. Range Manage.* **36:** 472-474.

Steel, R.G. and **Torrie, J.H.** (1981) *Principals and Procedures of Statistics.* (2nd). Ed. McGraw-Hill Book Company. 633 p.

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

Tag El Din, S.S. (1983) Range resources of Hamad Basin in Saudi Arabia. ACSAD / HAMAD / Final Report, 21.

Wilson, A.D. (1969) A review of browse in the nutrition of grazing animals. *J. Range Manage.* **22:** 23-28.

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تأثير موسم الرعي على الانتاجية الرعوية لبعض شجيرات المراعي

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تتميز المناطق الجافة وشبه الجافة باختلاف انتاجية المراعي الطبيعية بها خلال السنة من موسم الى آخر حيث أعلى انتاجية في موسم الربيع لنمو الحوليات. واقل انتاجية في الخريف لاختفاء الحوليات ورعي المعمرات وإحدى استراتيجيات تحسين المراعي تعتمد على تقليل الفرق في الانتاجية بين المواسم. ويتحقق ذلك من خلال زيادة الكثافة النباتية للشجيرات المعمرة سواء داخل المرعى أو بزراعتها كمكمل للمرعى الطبيعي.

تهدف هذه الدراسة إلى تقدير الانتاجية الخضرية الكلية وانتاجية السنة الجارية لبعض الشجيرات الرعوية عند قطفها في المواسم المختلفة. والشجيرات تحت الدراسة هي القطف الملحي والقطف الاسترالي والقطف الأمريكي وقطف البولي كاربا والروثة، والمحددات التي درست هي الانتاجية الخضرية الكلية والانتاجية الجافة الكلية، وكل من الانتاجية الخضرية والجافة للسنة الجارية. حيث أخذت البيانات لمدة سنتين في المواسم الاربعة.

وتوصلت النتائج الى:

- متوسط السنوات لمحددات الانتاجية في الربيع والصيف أعلى وبفرق معنوي عن الانتاجية للخريف والشتاء.

- أظهر متوسط السنوات أن الانتاجية الخضرية سواء الكلية أو للسنة الجارية أعلى في الربيع عن الصيف وبفرق غير معنوي بينما العكس في الانتاجية الجافة حيث انتاجية الصيف أعلى من الربيع.
- توجد اختلافات معنوية لجميع محددات الانتاجية بين الانواع المختلفة خلال جميع المواسم عدا انتاجية المادة الجافة الكلية في كل من الخريف والشتاء. والانتاجية الجافة للسنة الجارية في الصيف فقط في السنة الأولى.
- تشير اتجاهات الانتاجية إلى أن أعلى انتاجية للقطف الاسترالي يليه القطف الملحي ثم القطف الامريكي فالروثة فقطف البولي كاربا.
- يعتمد رعي الشجيرات الرعوية إلى حد كبير على حالة المرعى الطبيعي - فإذا كان المرعى الطبيعي ضعيف جداً الى ضعيف، أو أن الحيوانات تعتمد فقط على هذه الشجيرات فيمكن البدء في رعيها في فصل الربيع. وفي حالة المرعى المتوسط يمكن البدء في الصيف بينما في حالة المرعى الجيد يمكن بداية الرعي في الخريف والشتاء.
- عند اختيار أنواع الشجيرات الرعوية. يؤخذ في الاعتبار بعض العوامل الأخرى بجانب محددات الانتاجية مثل الاستساغة النسبية والاقلمة. ومدى مساهمتها في صيانة التربة. . . الخ.