Productivity of Irrigated Tropical Grasses under Different Clipping Frequencies in the Semidesert Region of the Sudan

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Abstract

On irrigated pastures, buffel grass, rhodes grass, bambatsi panicgrass, and green panicgrass were generally more productive than para grass, blue panic, and switchgrass. Clipping at 4- and 6-week intervals during the summer resulted in greater total annual yield than clipping at 2-week intervals. However, percent crude protein in grasses clipped at 2-week intervals was double that in grasses clipped at 6-week intervals. Swtichgrass, para grass, and blue panic appeared least able to withstand clipping over the 2-year period of the study. The results suggested that buffel grass, green panic, bambatsi panic, and rhodes grass, harvested at 4-week intervals would be the best choice for production of nutritious forage on irrigated pastures in the semiarid region of the Sudan.

Sudan is a vast country of nearly one million square miles that lies between latitude 21° 55′ N. and 3° 53′ N. and longitude 21° 54′E. and 38° 30′E. Ecological zones within this area range from the deserts and semideserts in the north to the tropical rainforests and swamps in the south. The semidesert region, with less than 300 mm annual rainfall, supports natural vegetation consisting mainly of annual grasses intermingled with short woody plants mostly of the genera *Acacia* (Harrison 1955). Sheep, goats, camels, and a few cattle utilize this zone. The region as such does not support large numbers of livestock at present (FAO 1968). This is probably why there are fewer cases of the epidemic viral, bacterial, and protozoal diseases found in the other wetter ecological regions of the country. A large area of this region was, therefore, designated to serve as a disease-free zone. At various times of the year, large numbers of livestock coming from different parts of the country enter and stay for some time in this zone for inspection under quarantine measures before they are exported. Consequently, animal fodder is in great demand.

During most of the year, animals in this region depend upon the remains of crops or forage produced under irrigation. The only forages grown especially for animals are 'lubia' (*Dolichos lablab* L.), dura forage (*Sorghum bicolor* var. 'Abu sabain'), lucerne (*Medicago sativa* L.), and 'dukhn' (*Pennisetum typhoides* (Burn.) Stapf and Hubbarad) produced on a limited scale under flood irrigation. Usually lubia and lucerne are cut and utilized as green forage, while the dukhn and sorghum are cut as mature straw and stored in stacks to be utilized later during winter and early summer. Mature straw of both species is highly deficient in crude protein (CP). Values as low as 2.5% for sorghum straw and 1.6% for dukhn straw were reported by Snow (1952). Moreover, the acreage of land occupied by forage

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Manuscript received February 2, 1978.

crops is continuously decreasing to provide room for more important cash crops.

Irrigated pastures have not contributed appreciably to the animal feed. Species such as *Cynodon dactylon* Pers. ('nagil'); *Echinochloa colona* link. ('difra') and *Sorghum sudanense* Stapf. ('garawia') are treated as agricultural weeds which may be used by livestock after harvesting the main crop. The desire to establish dairy farms in this region to supply dairy products for the cities and towns is increasing. Irrigated pastures could be a reliable source of good quality forage, and grasses may be treated as an irrigated crop rather than a weed.

The objective of this study was to compare the persistence and productivity of two native and five introduced warm-season grasses under three frequencies of clipping when irrigation was adequate.

Methods and Procedures

The experiment was conducted at the farm of the University of Khartoum, Shambat, Sudan. The soil is a heavy alkaline clay soil with pH 7.5–8.0 and clay content 50–60%. This semidesert region has an average annual rainfall of 160 mm coming mostly during July and August. The minimum and maximum temperatures range between 13° and 27°C in January and between 25° and 41°C in May. May is the hottest month of the year, and temperature drops gradually by 4° to 5°C during the rainy season in July and August.

The grasses tested were native species: switchgrass (*Panicum virgatum* L.) and buffel grass (*Cenchrus cilaris* L.) and introduced species: para grass (*Brachiaria mutica* (Forsk.) Stapf), green panic (*Panicum maximum* Jacq. var. *trichoglume*), blue panic (*Panicum antidotale* Retz.), bambatsi panic (*Panicum coloratum* L.), and rhodes grass (*Chloris gayana* Kunth).

The switchgrass was an ecotype obtained from a river bank near Kassala, Kassala province, while the buffel grass was collected from Singa area, Blue Nile province (rainfall >500 mm). The introduced grasses came from Australia and were chosen following preliminary adaptability trials on a large number of species carried out by the Range Department administration, Khartoum, Sudan. All grasses were seeded on 2 × 5-m plots in April, 1976, and irrigated every week. All plots were cut to a 14-cm height on July 10, 1976; three cutting frequencies were then imposed. These frequencies were at 2-, 4-, and 6-week intervals to the same 14-cm height. A split-plot experimental design was used with the seven species on the main plots and the cutting frequencies on sub-plots. There were four replications.

Cutting was discontinued in November, 1976, and resumed in March, 1977, after an initial cut for all the plots. The treatments were continued until November, 1977. The plots of 2-, 4-, and 6-week frequencies were cut 7, 4, and 3 times respectively during the first year and 18, 9, and 6 times during the second year. Harvested material was oven dried to a constant weight at 70°C and weighed. Percent crude protein (CP) in samples representing all treatments and replications from the first-year material was estimated from the determination of N by Kjeldahl technique.

Results and Discussion

The 2-week clipping treatment produced the lowest yield in all the species (Table 1). During the first season, the mean value for this treatment was only 68 and 50% of the yield obtained at 4- and 6-week clipping intervals, respectively, and 59 and 69% of the same values during the second season. Similar yield reduction as a result of frequent defoliation of grasses was reported by many authors (Singh and Mall 1976; Perry and Chapman 1975; Bekele et al. 1974; Owensby et al. 1974). Apparently the 2-week cutting frequency reduced leaf area and consequently reduced the amount of food material translocated to the roots which supports new growth. Other workers have found that carbohydrate reserves may play a more important role than remaining leaf area in regrowth immediately after defoliation (Davidson and Milthorpe 1966; Ward and Blaser 1961).

Some species were not as severely affected by the 2-week cutting intervals during the first season as they were the second season. For example yields were not significantly different between the 2- or 4-week intervals the first year for buffel grass, rhodes grass, and bambatsi panicgrass. Those same species were also the highest producers among the seven species under the 2-week frequency during this period. The total yield of switchgrass and blue panic on the other hand was greatly depressed by the 2-week clipping. Dry matter yield of the switchgrass was three times greater when clipped at 6-weeks instead of 2-weeks. Similarly, the yield of blue panic was two and three times greater when clipped at 4 and 6 weeks, respectively, instead of 2 weeks. Green panic produced twice as much dry matter when harvested at 4- instead of 2-week intervals. Para grass was not only the lowest producer of all the species but recovered slowly from defoliation as well. This species is more adapted to the humid tropical and subtropical areas (FAO 1959).

Switchgrass, para grass, and blue panic that were clipped at 2-week frequency began to show signs of deterioration after the fourth cut during the first season. Switchgrass was the most affected of all the species by the 2-week cuttings; yields were reduced by 70, 85, and 86% of the fourth cut in the fifth, sixth, and seventh cut, respectively. Yield reduction in other species did not reach such magnitude except for para grass and bambatsi panic in their final two clippings.

Species more tolerant to the 2-week frequency of clipping during the first season also produced the highest average yields during the extended period of harvesting in the second season. The average yields of these species increased considerably over the first season yields. This was probably due to the greater number of harvest cycles imposed during the second season.

Table 1. Total forage production (kg/ha, oven dry) of seven grass species under three cutting frequencies.[1]

Grasses	1976				1977			
	2 weeks	4 weeks	6 weeks	Mean	2 weeks	4 weeks	6 weeks	Mean
Para grass	600	1124	824 NS	849 d	1134	2743	2518 NS	2131 c
Buffel grass	2492 b	3569 b	5133 a	3731 a	5054 b	8577 a	9077 a	7569 a
Green panic	1535 b	3030 a	3391 a	2652 b	3220 b	5478 a	4305 a	4334 b
Blue panic	797 b	1714 ab	2174 a	1562 cd	1253	3030	1583 NS	1955 c
Bambatsi panic	2101	2295	3115 NS	2503 bc	4534 b	6040 a	7243 a	5939 ab
Switchgrass	1184 b	1566 b	3627 a	2126 bc	1494	2784	2718 NS	2332 c
Rhodes grass	2060 b	2449 b	3715 a	2741 b	4055 b	6051 a	5789 a	5298 b
Mean	1538 c	2249 b	3139 a		2963 b	4957 a	4747 a	

[1] Treatments means for each species (rows) and species final means (columns) followed by the same letter do not differ significantly at 5% level by Duncan's multiple range test.

The relative productivity of the species with the extended harvest cycles was different. For instance, buffel grass produced 3,838 kg/ha over the first season, while the increments were 3,436 kg/ha and 2,557 kg/ha for bambatsi and rhodes grass, respectively. Change in yield for green panic was only moderate, amounting to 1,682 kg/ha over the first season. Although higher dry matter as compared with the first season could be harvested from para grass during the second season, it remained one of the three lowest producers of all seven grasses. The switchgrass and blue panic seemed to have produced very little more in yield over the first season, with only 206 and 393 kg/ha, respectively. This was due to the deteriorated stand in plots of all treatments for both species. Beaty and Powell (1976) showed that two or more clippings per season of pungburn switchgrass (*Panicum virgatum* L.) reduced forage production, clonal survival, tiller number per clone, and tiller height. Jung et al. (1974) clipped blackwell switchgrass three, five, or eight times during each of 2 years and found that it deteriorated badly after 2 years regardless of treatment. Spiers and Holt (1971) observed a decline in vigor of blue panic in years subsequent to establishment. The 2-week frequency of clipping was more severe for some species than for others especially during the second season, when 18 cuts were attempted. In some plots of species affected most by this treatment during the first season (switchgrass, blue panic, and para grass), there was virtually nothing to be harvested after the ninth cut.

Although clipping at 6-week intervals resulted in the maximum dry matter production, especially during the first season, it was accompanied by serious reduction in crude protein percentages (Table 2). Crude protein was reduced by 50% or more when herbage was clipped after 6 weeks instead of 2 weeks.

Table 2. Crude protein content (%) as affected by cutting date.[1]

	1976			
Grasses	2 weeks	4 weeks	6 weeks	Mean
Para grass	13.75[2] a	7.47 b	6.55 b	9.26 bcd
Buffel grass	10.97 a	6.42 b	5.07 b	7.49 d
Green panic	12.80 a	8.15 b	6.40 b	9.12 bcd
Blue panic	14.85 a	9.77 b	7.82 b	10.81 ab
Bambatsi panic	14.05 a	8.72 b	6.25 b	9.67 bc
Switchgrass	18.05 a	9.30 b	7.87 b	11.74 a
Rhodes grass	10.07 a	7.52 ab	5.82 b	7.80 cd
Mean	13.50 a	8.19 b	6.54 c	

[1] Each value is a mean of four replications.

[2] Treatments means for each species (rows) and species final means (column) followed by the same letter do not differ significantly at 5% level by Duncan's multiple range test.

Reduction of such magnitude will be more serious for the highly productive species such as buffel grass and rhodes grass, which were of relatively lower CP at all clipping intervals. It would therefore seem advisable to utilize those two species at frequent intervals when CP is relatively high and herbage yield is moderate. Late utilization of these two species would result in accumulation of dead, dry stubble. It was observed that the vegetation on plots of the above two species, which were harvested biweekly, remained green as compared with those clipped at 4- and 6-week frequencies; the 2-week frequency plots were preferred by sheep and goats allowed free grazing on the plots in November 1977. The three panic grasses and the switchgrass were generally highest in CP of all the seven species when clipped at 2-week intervals, and maintained the highest percentages when clipped at 4-weeks. The panic grasses and switchgrass could probably be utilized at the wider 4-week interval to obtain a higher yield and still benefit from the relatively high CP. However, switchgrass and blue panic appeared least able to withstand clipping over the 2-year period of this study.

The performance of the seven grasses during both seasons is shown by Table 3. All the species were favoured by the warm weather conditions from May to October, but yield was drastically reduced by winter, November through February. Buffel grass produced the highest average monthly yield of all the species during the first season and in 7 out of 9 months during the second season.

The results of this study suggest that buffel grass, rhodes grass, bambatsi panic grass, and green panic grass harvested at 4-week intervals would be the best choice for production of nutritious forage on irrigated pastures in the semiarid region of the Sudan. The former two species can even be harvested at a shorter interval of 2 weeks to secure a relatively higher CP percentage of the forage, but with moderate yields.

Further study is needed to evaluate the response of these promising species to nitrogen fertilization or when grown as mixtures with legumes.

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Table 3. Monthly dry matter yield (kg/ha).[1]

	1976				1977								
Grasses	August	Sept.	October	Nov.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Para grass	183	277	351	130	102	134	506	204	239	413	125	163	76
Buffel grass	1115	1122	1301	566	655	426	965	1035	1089	1280	803	818	534
Green panic	795	783	883	450	153	303	788	540	590	772	331	432	227
Blue panic	584	469	422	242	136	115	402	220	197	333	175	209	111
Banbatsi panic	634	681	1034	434	313	300	1293	755	1011	1079	511	635	239
Switchgrass	613	497	892	340	124	184	501	182	376	324	134	223	98
Rhodes grass	908	818	914	469	400	608	1216	434	658	580	270	450	286
LSD	308	279	473	246	497	233	401	220	336	373	258	246	139

[1] Each value is an average of 2 or 3 means representing the different cutting frequencies, except the value for March which represents the mean for the 2-week cutting frequency.

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