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Response of Selected Tropical Grasses to Irrigation with Brackish Water

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ABSTRAK

Program pembangunan pertanian di kawasan-kawasan berpasir zon kering Sri Lanka telah mencadangkan penubuhan foder yang sesuai untuk ternakan di bawah program pengairan menggunakan air masin bawah tanah. Satu kajian telah menilai tindak balas tiga jenis rumput tropikal yang popular dan satu spesis asli yang ditanam di tanah berpasir terhadap pengairan menggunakan air masin yang mempunyai konduktiviti 0.5-6.0 ms.cm. Kajian telah dijalankan selama 6-7 bulan dengan pengairan yang disesuaikan dengan musim kemarau. Pertumbuhan ketiga-tiga spesis dipengaruhi oleh peningkatan konduktiviti air. Brachia mutica *adalah spesis yang paling terjejas. Penghasilan* Papalum dilatatum *pula tidak begitu terjejas dengan peningkatan kemasinan air.* Panicum maximum *memberi penghasilan tertinggi dan membekalkan kuantiti foder yang berpatutan di dalam semua keadaan. Walau bagaimanapun, spesis yang diperkenalkan memberi penghasilan yang lebih tinggi daripada spesis asli kecuali* Brachiara *pada tahap konduktiviti yang lebih tinggi. Data menunjukkan kesan kemasinan ke atas kadar penghasilan spesis pilihan dan dibentangkan di sini hasil kajian mengenai penanaman rumput menggunakan spesis-spesis ini di bawah sistem pengairan di kawasan berpasir pada musim kemarau.*

ABSTRACT

Agricultural development programmes in the sandy regions of the dry zone of Sri Lanka envisage the establishment of suitable fodder for livestock under irrigation programmes using brackish underground water. A study evaluated the response of three popular tropical grasses and the natural species to irrigation with brackish water having conductivities ranging from 0.5-6.0 ms.cm, when established in a sandy soil. The study was carried out for 6-7 months, with regular irrigation to correspond to the dry season. Growth of all three species was affected by increasing conductivity of water. Brachiaria mutica *was affected to the greatest extent. Yields of* Paspalum dilatatum *were reduced to a lesser extent with increasing brackishness of water.* Panicum maximum *produced the highest yield and provided a significant quantity of fodder in all treatments. However, the introduced species outyielded the natural species with the exception of* Brachiaria *at the higher levels of conductivity. The data illustrated the effect of brackishness on the yielding ability of the selected species. The practical significance of the study in terms of possible uses of these species in growing grasses under irrigation in the sandy tracts for herbage production in the dry season is presented.*

INTRODUCTION

The production of most plant communities is dependent on the availability of adequate soil moisture. This phenomenon is also true of grasslands of the tropics, which are subject to periods of severe moisture stress. Thus, total annual rainfall (le Honerou and Hoste 1977), annual and particularly monthly rainfall pattern (Duncan and Woodmansee 1975) or progressive seasonal total rainfall combined with temperature (Naveh 1982) can be correlated with herbage yields in most tropical rangelands.

Most rangelands in the tropical dry regions are considered resilient due to their capacity to persist through fluctuating yearly weather patterns (Naveh 1982). However, their persistence is associated with the presence of volunteer early maturing species. These species which are tussocky in nature tend to reduce their productivity with time (Biddescombe 1987). The lack of adequate fertility, the presence of alkali soils and the absence of proper grazing management also affect their productivity.

The rangelands of Sri Lanka account for some 700,000 ha of land, spread primarily over the dry zone (Rajaguru 1986). They consist of grasses and tussocky perennial shrubs which provide low quality herbage. Grasses such as *Imperata, Cynodon* and *Panicum* dominate these rangelands which are found over a wide range of soils. The productive capacity of these rangelands especially in the dry zone, is affected by the unevenly distributed rainfall due to the presence of a dry period for 5-6 months of each year. Thus seasonal productivity is a common feature in these rangelands.

The rangelands of the north western coastal regions of Sri Lanka are characterised by the presence of alkali and sandy soils. The species growing on these rangelands also tend to be coarse and tussocky, and their productivity is dependent on rainfall and soil conditions. Thus during dry periods the species tend to wither, leaving dead or unpalatable material for animals. Another characteristic feature of this region is the presence of a high water table (304 m below soil surface). The quality of the water varies with location and season and the conductivity of water changes rapidly (0.4-8 #ms/cm). This ground water, which is easily accessible, could successfully be used for production of fodder crops to provide adequate food for livestock during the dry period.

Agricultural development programmes envisage the improvement of grazing lands of the dry regions which have an immense potential for producing adequate feed for livestock (Rajaguru 1986). In the north western region, the development programmes envisage the use of ground water. However, salinity of the water affects the growth of most grass species (Whiteman 1980), and all tropical species do not respond similarly to brackish water (Bogdan 1977). Studies and surveys (e.g. Russel 1976) illustrate different degrees of salt tolerance of tropical herbage species.

Studies on the comparative performance of tropical herbage species under irrigation, especially with brackish water, are not widely reported in Sri Lanka. However, the use of available ground water is an important phenomenon in improving rangelands. A case study was carried out on a sandy tract in the north western region of Sri Lanka to evaluate the performance of three selected grasses, and to compare their performance with that of the natural species when provided with irrigation water having different conductivities. The principal objective of the programme was to study their performance in the dry season as productivity is generally adequate in the wet season for animal requirements.

MATERIALS AND METHODS

The study was carried out at a site on a sandy tract, which is typical of the soils of the region, over a period of eight months that corresponded to the annual dry season. The selected site contained the indigenous species prior to the development of the trial. The water table of the location was at a depth of 3.5-4. m from the soil surface.

The species selected were *Brachiari mutica, Paspalum dilatatum* and *Panicum maximum* which are grown widely in different environments of the tropics (Bogdan 1977). The experimental design used was a randomized block design with three replicates.

The grasses were established from uniform vegetative propagules on 2 × 3 plots at the onset of rains and maintained for one year. The spacing adopted was 30 × 40 cm. In addition, similar sized plots of the indigenous species were also maintained for comparison. A uniform fertilizer rate equivalent to 800 Kg/ha of a 15: 10: 15 N:P:K mixture was applied once in six months to all plots prior to the beginning of the trial.

The herbage of all plots were cut to a uniform height of 4 cm at the end of the rainy season (early January - 15 months after planting), before the experiment was initiated. During the experimental period, which corresponded to the dry season, the separated plots of each species were irrigated manually with ground water having four different levels of brackishness (measured by conductivity, using a standard conductivity meter once a month). The water, obtained from adjacent sources (wells) had a mean conductivity of 0.5 ms/cm ± 0.06; 2.1 ms/cm ± 0.13; 4.2 ms/cm ± 0.42 and 5.9 ms/cm ± 0.21 over the experimental period. These treatments were termed C1, C2, C3 and C4 respectively. The rate of application of water was 30 l per plot at 8-10 d intervals, to correspond to flood irrigation as practised by farmers of the region. The herbage of each plot was harvested at two monthly intervals over the experimental period. Thus, four harvests were taken from February to August by cutting to a height of 5 cm above ground level. The herbage harvested was dried at 80°C to a constant weight and dry matter contents were determined.

RESULTS AND DISCUSSION

The climatic parameters during the experimental period and important soil characteristics of the site are presented in Table 1. The rainfall over the period, the temperature and estimated evapotranspiration rates are similar to the long term (10 year) mean values of the region. This indicates that the climate of the season of study conformed to that of the general climatic parameters of the region.

The total rainfall over the experimental period was 368 mm, which was approximately 25% of the annual rainfall. This is a characteristic feature of the dry season on the dry zone of Sri Lanka (Domros 1974). The high temperature resulted in high evapotranspiration rates. Thus, the quantity of water lost to the atmosphere exceeded rainfall, resulting in the upward movement of brackish water from the ground water table. This, as suggested by Hanson *et al* (1979) increased the salinity level of the soil especially in the dry season, which is characteristic of this region. In the wet season high rainfall could leach the soil, thus preventing the build up of excessive levels of salinity with time.

The soil characteristics illustrate the sandy nature of the site, and the relative high conductivity. The pH suggested alkali conditions and the percentage organic carbon was very low due to the rapid degradation of any added material. The water holding capacity of the soil was also low. (Table 1). These parameters, coupled with the climatic conditions of the dry season, make crop production difficult in this region under rainfed conditions.

Dry Matter Productivity

The productivity of natural species and of *Brachiaria* when grown with irrigation using ground water of different brackishness over the dry season is presented in Table 2. The dry matter productivity of both species was less at the second harvest due to the low rainfall. Thereafter, yields increased due to some rainfall during the monsoon, which however, was less than the estimated evapotranspiration rates. The phenomenon affected both species even with the supply of irrigation in all treatments, irrespective of the increasing brackishness. A comparison of the productivity of the two species illustrated the high yielding ability of *Brachiaria* when irrigated

TABLE 1
Mean climatic and selected soil parameters of the experimental site.

A. Climatic Factors	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rainfall (mm/month)	119	54	11	12	25	49	65	21	12
Mean monthly rainfall (mm/month)	140	41	18	16	31	52	74	15	08
Mean monthly temp. C°	29.1	29.5	29.1	29.9	30.4	30.8	30.1	29.9	30.4
Mean monthly temp. for 10 years	28.4	29.2	29.3	29.6	30.1	30.5	29.9	30.3	30.8
Estimated ET (mm/day)	4.7	6.1	6.2	6.0	5.4	5.0	6.1	6.2	5.8
Mean of 5 years (mm/dy)	4.8	6.1	6.5	5.9	5.9	5.2	6.5	6.3	5.9

B. Soil Factors		
Texture	Sandy (79.5% ± 1.59 sand)	pH - 7.98 ± 0.44 (1:25 H_2O)
Water holding capacity	14.5% ± 2.42 v/v	Conductivity - 2.98 ms/cm ± 0.23
% Organic matter	0.094% ± 0.013	

with good quality water. This indicated the potential of introducing high yielding grasses to provide adequate fodder for livestock by the provision of good quality irrigation water which is available in some parts of this region. However, with the increasing brackishness of water, the productivity of *Brachiaria* was less but greater than that of the natural species found in the region. This suggests that if the available ground water had a higher conductivity, the use of indigenous grasses would be a more viable source of fodder than species such as *Brachiaria* which are considered susceptible to salinity (Bogdan 1977). Table 3 presents the productivity of *Paspalum* and *Panicum* over the experimental period. At all harvests the herbage yields of both species exceeded those of the natural species and *Brachiaria*. This illustrates the greater

TABLE 2
Response of natural species and *Brachiaria* to irrigation with brackish water

Treatments		Herbage Yields (g/dry matter/m²)			
Species	*Irrigation*	H1	H2	H3	H4
Natural Species	C1	51	18	24	39
	C2	44	13	20	31
	C3	33	11	16	26
	C4	28	9	12	19
S.E. (Mean)		2.47	1.86	4.23	5.12
Brachiaria	C1	85	31	69	81
	C2	61	20	45	59
	C3	24	14	30	21
	C4	10	7	10	15
S.E. (Mean)		7.14	2.77	8.04	9.12

C1 = brackishness of 0.5 ms/cm ± 0.06
C2 = brackishness of 2.1 ms/cm ± 0.13
C3 = brackishness of 4.2 ms/cm ± 0.42
C4 = brackishness of 5.9 ms/cm ± 0.21

TABLE 3
Response of *Paspalum* and *Panicum* to irrigation with brackish water

Treatments		Herbage Yields (g/dry matter/m)			
Species	*Irrigation*	H1	H2	H3	H4
Paspalum	C1	128	49	80	99
	C2	104	41	70	75
	C3	91	33	61	66
	C4	80	25	53	45
S.E. (Mean)		3.05	6.11	5.08	4.12
Panicum	C1	178	70	95	135
	C2	154	58	76	118
	C3	136	51	61	101
	C4	121	46	54	89
S.E. (Mean)		4.17	8.82	9.17	5.98

C1 = brackishness of 0.5 ms/cm ± 0.06
C2 = brackishness of 2.1 ms/cm ± 0.13
C3 = brackishness of 4.2 ms/cm ± 0.42
C4 = brackishness of 5.9 ms/cm ± 0.21

adaptability of these two species to different qualities of irrigation water. A comparison of the productivity of the two species (Table 3) indicates the higher yields of *Panicum* at all harvests in all treatments. This clearly illustrates the suitability of *Panicum* as an adaptable species for the dry regions; and its capacity to produce relatively higher yields especially in the dry season when provided with irrigation using brackish water. The data also confirmed earlier reports (e.g. Russel 1976, Whiteman 1980) of the tolerance of Panicum to alkaline conditions. The cumulative yields obtained over the season from the four types or herbage when irrigated with water of different levels of brackishness are presented in *Fig. 1*. The data illustrate the poor yielding ability of the natural species irrespective of the different types of irrigation water. This suggests that these rangelands require improved species to increase their productivity even in the presence of irrigation water as the natural species do not seem to have the inherent capacity to respond to irrigation even with good quality water. *Fig. 1* also illustrates the high yielding ability of *Panicum* in dry season environmental conditions supplemented with irrigation using water of different levels of brackishness. The yields of *Paspalum* which are lower than those of *Panicum* showed greater adaptability than *Brachiaria*.

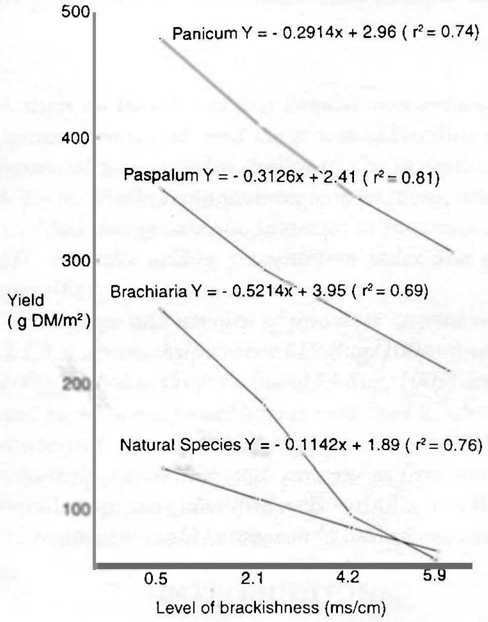

Fig. 1: Effect of brackishness of irrigation water on cumulative herbage yields

Regression equations (*Fig. 1*) for the cumulative yield data of all species show the decline of yields of species with increasing brackishness of irrigation water. Amongst the species tested, the natural species are least susceptible to increasing brackishness of irrigation water. *Brachiaria* is affected to the greatest extent. The yield decrease in *Brachiaria* was approximately 30% between the C1 and C2 treatments and by 45% between C2, C3 and C4 treatments. This also illustrates the unsuitability of *Brachiaria* for the rangelands of these regions, especially if irrigation is provided with water having a high level of brackishness. The yield decline of *Panicum Paspalum* and the natural species is around 15 - 20% between the irrigation treatments. However, although the reduced yield with increasing brackishness is greater in *Panicum*, its highest yields in all treatments highlight the adaptability of this species to the environmental conditions with irrigation from different qualities of water.

CONCLUSION

In terms of practical benefits, the pasture improvement programmes of this region are of vital importance to the livestock industry (Rajaguru 1986). The land available for pastures is generally not suited for cropping due to the alkaline nature of the sandy soil, and the brackishness of ground water. Improvement of these rangelands requires adaptable species, especially to provide fodder for the animals during the dry season. The results suggest the possibilities of using species such as *Panicum* and *Paspalum* for this purpose. These species which are tolerant to brackishness could be useful in increasing the productivity of these rangelands in combination with the readily available source of ground water, especially during the dry period when other types of vegetation succumb to the harsh environmental conditions.

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