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Potentials of Forage Crops in Saudi Arabia

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ABSTRACT. A number of warm season grasses imported from the United States, Australia and Kenya were tried at different locations in the Kingdom to evaluate their production potentials and nutritive values and to compare these with other forage crops. Among these, Blue panic (Panicum antidotale), Klein grass (Panicum coloratum), Love grass (Eragrostis superba) and Signal grass (Brachiaria decumbens) were found successful at many locations, however Blue panic surpassed all other species producing 150 to 180 tons of green material per hectare per year with 15 to 18% protein. Blue panic was also highly tolerant to high level of salinity (15000 ppm) and drought, using almost 50% less water than alfalfa. Comparison with other forage crops indicate that Blue panic is certainly more productive and nutritionally more acceptable than Rhodes grass (Chloris gayana).

The demand for forage crops to produce fresh green materials for livestock consumption has increased significantly in Saudi Arabia during the past 20 years due to the increase in milk and meat producing animals. At present, alfalfa and Rhodes grass are the only main crops grown for forage production with sorghum, Sudan grass and maize filling in the gaps to a much lesser extent. Most of the animal feed containing protein-rich ingredients are imported at astronomically high cost by the government and given to farmers at subsidized rates.

Climatically Saudi Arabia is characterized by high temperatures, high humidity, high solar irradiance, and high salinity. Water is the most important limiting factor for crop production. Efficient utilization of this important resource requires research on crops that have high water-use-efficiency and are adaptable to the harsh environment of the Kingdom. The objectives of this study were:

1. To evaluate the production potentials, adaptability and nutritive values of warm season grasses introduced into the Kingdom.

2. To evaluate their performance at various locations in the Kingdom representing contrasting soil and climatic conditions.

Materials and Methods

Several species of warm season grasses, namely Blue panic (Panicum antidotale), Klein grass-75 (Panicum coloratum), Love grass (Eragrostis superba), Old World Bluestems (Bothriochloa spp.), Signal grass (Brachiaria decumbens), Setaria (Setaria anceps) and Rhodes grass (Chloris gayana) were planted at Al-Kharj, Dirab, Qatif, Riyadh and Jizan during 1983-84 and during 1984-85 growing season.

Table 1 shows the location and characteristics of each site. All species were not planted at all the locations except Blue panic and Klein grass. Plot size varied from 3 × 5 to 3 × 20m. Blue panic was replicated four times. Other species were replicated at least three times. Before planting, fertilizer was applied to each plot at the rate of 30 Kg N, and 30 Kg P_2O_5/h. Following every harvest, 50 Kg N/h was applied. Seeds were planted in April or May in rows, 30 cm apart and 1 to 1.5 cm deep. Plots were irrigated daily for 10 days following planting.

Table 1. Characteristics of Study Sites

Site	Elevation above Sea level (meters)	Mean Annual Rainfall (mm)	Mean Annual Temperature (°C)	Relative Humidity (%)	Annual Evapo-transpiration (mm)	ECe (Soil) (dsm^{-1})
Al-Kharj	400-600	50-110	24-27	32-45	1800-2500	1.5-2.7
Dirab	400-500	50-110	22-27	32-45	1800-2500	1.6-2.3
Qatif	20-25	60-120	23-28	46-58	2000-2600	16-20
Jizan	20-50	150-220	25-32	58-68	2400-2900	4.5-6.7

When the seedlings were about 10 cm above the ground, irrigation was reduced to once a week during June, July and August and to once in two weeks during September, October and November. During December, January and February, irrigation was done once a month, because during these months the plants were either dormant or growing very slowly. Irrigation at all the locations was through flooding. Plants were ready for harvest 45 days from planting. At each harvest, whole plots were harvested and weighed. A subsample was taken from each plot for percent dry matter, protein and carbohydrate determinations.

Each sample was dried in a forced air dryer at 70°C for 48 h, and ground in a willy mill to pass 40 mesh screen. A subsample of the ground material was taken for nitrogen determination using Kjeldahl procedures. Protein was determined by using % N × 6.25. Total nonstructural carbohydrates (TNC) were determined by the procedure outlined by Smith (1969).

For comparison with other forage crops tried in Saudi Arabia at one time or another in the past, data were collected from different sources as indicated along each table.

Results and Discussion

Results on the productivity and growth of introduced grasses are shown in Table 2. Three species, namely Blue panic, Klein grass and Love grass were found successful at all the locations. Signal grass which was planted only at Al-Kharj produced reasonably good yield even during the first year of establishment. Old World Bluestem did very well for two years but in subsequent years the stand was reduced and invaded by Blue panic and Rhodes grass. Blue panic persisted at all the locations, still producing relatively higher yield than Klein grass and Love grass. Love grass which did very well in the first year at Qatif and Dirab is declining at Qatif but doing very well at Dirab.

Table 2. Fresh Weight (Tons/h) of Warm Season Grasses at Different Locations in the Kingdom

Species	Locations				No.cuttings per year
	Jizan	Dirab	Al-Kharj	Qatif	
Blue Panic	100-180	90-120	60-110	70-115	10-12
Klein Grass	130-150	95-105	50-90	60-90	6-8
Love Grass	110-150	40-60	60-80	60-80	3-4
Old World Blue Stems	--	--	20-30	--	1-2
Signal Grass	--	--	80-90	--	3-4

At Qatif the soil salinity ranges from 15,000 to 20,000 ppm and Love grass as well as Klein grass cannot tolerate high level of salinity. Blue panic appears to have developed resistance to high salt concentration. The yield of Blue panic was higher than the other grasses at all the locations (Table 2). At Dirab, plots were irrigated with Riyadh city sewage water which contains high concentration of ammonium nitrogen and therefore did not require fertilization with nitrogen. Fresh weight of each species as shown in Table 2, is cumulative yield of several

cuttings. On the average, Blue panic produced green forage throughout the year in 10 to 12 cuttings which is much higher than other species (Table 2). Blue panic and Klein grass were also planted at RAWRC under palm trees and the production obtained during 1986 was comparable to other locations (120-140 tons/h). This preliminary data of 3-4 years indicate that Blue panic and Klein grass, if properly managed, will have a definite place in the overall Kingdom's forage crops production especially for dairy farms.

Table 3 shows the protein contents of these grasses which is relatively much higher than other forages grown in the Kingdom (Table 4). Warm season grasses which operate on the C_4-photosynthetic pathway (Osmond *et al.* 1980) are usually more efficient utilizers of available resources than cool season grasses. The species studied all belong to the C_4-photosynthetic pathway system. These grasses continue their photosynthesis at high rates with increasing light intensity and high temperatures. On the average the protein contents range from 15% to 18% which is comparable to alfalfa (18% to 22%). Protein contents of Blue panic and Klein grass did not fluctuate between cuttings provided plants were harvested at the pre-bloom stage. Mature plants following flowering are less nutritional due to high fiber contents. In Saudi Arabia, alfalfa, especially the local cultivars known by several names such as Hasawi, Qatifee and Hijazi is well-adapted to a wide range of soil and climatic conditions. However, the water-use-efficiency of alfalfa is very low. Besides, alfalfa if grown under the pivot system of irrigation, becomes suceptible to many pathogenic diseases. Alfalfa is also very low in dry matter (18-20%) compared to grasses (30-40%).

Table 3. Protein (%) of Warm Season Grasses at Different Locations in the Kingdom

Species	Locations			
	Jizan	**Dirab**	**Al-Kharj**	**Qatif**
Blue Panic	15-20	15-20	15-18	15-18
Klein Grass	15-18	16-19	15-20	15-18
Love Grass	12-15	12-16	13-17	12-16
Old World Blue Stems	–	–	10-15	–
Signal Grass	–	–	15-18	–

For best results, it is advisable to grow alfalfa and grasses in separate fields and feed them in mixture to dairy cows. Feeding in mixture will eliminate the problem of low dry matter in alfalfa which will be compensated by the high dry matter contents of grasses. Similarly, alfalfa will contribute to the relatively low protein contents in grasses.

Table 4 gives proximate analyses of different types of forages tried in Saudi Arabia during the past several years at different locations. Blue panic and Klein grasses are much higher in protein, in-vitro dry matter digestibility (IVDMD) and productivity as compared to Rhodes grass. Rhodes grass has been growing in Saudi Arabia for more than 30 years and has adapted to contrasting soil and climatic conditions of the Kingdom, however its protein content is very low. It becomes less digestible with advancing maturity due to accumulation of lignin. Generally, as is evident from Table 4, Rhodes grass is not nutritionally as high as Blue panic and Klein grass.

Table 4. Major Chemical Components of Important Forage Crops in Saudi Arabia

Species	As % of Dry Matter							Fresh Wt. (Tons/h)	Dry Wt. (Tons/h)
	DM	CP	CF	Ash	EE	NFE	IVDMD		
Rhodes Grass (Chloris gayana)	30.0	9.5	32.5	6.0	1.0	46.2	55.0	120	24
Blue panic (Panicum antidotale)	43.0	18.8	28.0	10.1	3.0	40.1	65.0	180	77
Klein grass (Panicum coloratum)	40.0	18.9	28.6	11.0	2.6	38.9	68.0	175	70
Alfalfa (Medicago sativa)	22.0	21.8	26.0	11.5	3.5	36.1	75.0	70	15
Love grass (Eragrostis superba)	30.0	11.3	32.3	6.6	1.9	47.9	65.0	90	27

DM = Dry matter, CP = Crude protein, CF = Crude fiber, EE = Ether extract, NFE = Nitrogen free extract, IVDMD = In-vitro dry matter disappearance

Table 5 was prepared by obtaining information from several publications of the joint agricultural project between University College of North Wales, Australia and Ministry of Agriculture, Saudi Arabia. Most of the work done by the above group was concentrated in the Al-Hassa region, mainly around Hofuf and most of the data reported were based in many cases on a single year experiment. However, this table shows the three important constituents contributing to the nutritional values of forages, namely protein, fiber and carbohydrates.

Among the commonly grown forage crops, alfalfa contains more protein, followed by Blue panic and Klein grass, than the rest of the forages. Blue panic and Klein grass contain slightly more carbohydrates and fiber than alfalfa and Rhodes grass. Higher fiber contents may reduce IVDMD slightly, but the higher carbohydrates will increase the total energy in-take of the feeding animals. Blue

panic and Klein grass will accumulate more non-digestible cellulosic materials if left uncut following flowering.

Table 5. Crude protein, crude fiber and available carbohydrate contents of different types of Forages grown in Saudi Arabia*

Crops	Protein (%)	Fiber (%)	Carbohydrate (%)
Alfalfa	18.25	24.27	5.51
Rhodes grass	11.65	30.57	5.80
Blue panic	17.30	33.20	7.20
Klein grass	17.00	31.20	6.81
Love grass	14.50	32.80	5.72
Signal grass	15.75	34.50	7.65
Setaria	14.30	35.10	7.30
Sorghum	8.16	27.04	18.12
Millet	14.20	25.42	11.59
Sudan grass	10.26	30.57	8.5
Rye grass	15.70	18.53	7.3
Bermuda grass	9.13	27.00	5.5
Barley	13.51	26.58	9.5
Oats	8.23	26.76	8.5
Wheat	10.64	27.33	12.2

* Partially adapted from various publications of Joint Agricultural Research & Development, University College of North Wales, Bangor, Australia & Ministry of Agriculture & Water, Kingdom of Saudi Arabia

Table 6 was prepared by obtaining information from various articles and books on forage crops. This table is presented here only for the purpose of getting an idea about the magnitude of variations among the important chemical constituents of various forages, which depends upon the location, the variety and stage of development of each species. This table can be used as a guideline for these values as expected under different soil and climatic conditions. In some species the ranges are wide enough to indicate their wide range of adaptability in several continents.

The list of forages in Table 6 belong either to C_4- or C_3-photosynthetic pathway *i.e.* these are either warm season or cool season forages which should be tried in the Kingdom to evaluate their performance during summer and winter period. In Saudi Arabia, winter is usually very mild but in some areas below freezing temperatures are encountered where warm season forages either stay dormant or slows down their growth. Cool season forages during winter will maintain the continuity of providing green materials to the animals..

Table 6. Chemical Composition of Common Forages*

Species	Dry Matter %	Ash %	Protein %	Lignin %	IVDMD %
Rhodes grass	20-30	6-13	8-10	5-6	50-60
Blue panic	43-46	8-13	8-18	4-6	60-70
Klein grass	30-40	7-15	9-18	5-6	50-60
Eragrostis superba	25-30	6-7	5-11	7-8	40-60
Eragrostis lehmanianan	25-30	8-9	6-10	4-5	60-70
Bermuda grass	19-40	6-12	8-14	5-6	50-60
Orchard grass	20-26	9-12	12-16	5-7	50-60
Alfalfa	17-20	8-15	16-20	2-3	70-80
Old World blue stems	20-30	5-13	8-13	4-6	50-60
Wheat straw	80-90	7-10	3-5	8-9	30-40
Barley, fresh (with seed)	20-23	10-12	11-20	4-6	50-80
Barley straw	80-90	9-17	3-6	7-8	30-40
Hyperhenia spp.	25-30	6-10	5-13	4-6	60-70

* Adapted from various publications on forage crops

Table 7. Data showing proximate composition, mineral elements* and total amino acids content of leaves of different *Atriplex* species grown at RAWRC Field Plots on January 15, 1978[1]

Name of Species	Crude Protein %	Fat %	Fiber %	Ash %	Nitrogen Free Extract %	Ca %	P %	Fe ug/g	Zn ug/g	Total amino acid (gm. amino acid/100 gm protein)
A. nummularia	25.0	1.1	10.4	24.3	39.0	1.44	0.24	420	54	70.21
A. canescens	17.4	1.6	9.0	18.5	53.5	1.31	0.19	370	59	56.40
A. vesicaria	17.8	1.6	8.3	34.1	38.2	2.48	0.18	350	58	78.95
A. rhagodioides	17.2	1.0	10.2	22.8	48.8	1.50	0.22	335	66	65.54
A. lentiformis	21.9	1.1	8.2	22.0	47.0	1.12	0.28	250	59	54.33
A. undulata	16.7	1.3	7.8	27.2	47.0	1.45	0.24	485	70	55.55

* Dry weight basis

1 Adapted from Dr. S.Z. Hyder studies conducted at RAWRC

Table 7 was adapted from the studies conducted by Dr. S.Z. Hyder at RAWRC on several species of atriplex. As is evident from this table, atriplex is a good source of nutrients, is very drought hardy and tolerant to salinity. However, atriplex is not palatable to many domestic animals due to accumulation of large quantities of salts and may be some phenolic compounds. However, species listed in Table 7 were found to persist under the harsh environment of the Kingdom. These species can be used successfully for landscaping and other aesthetic purposes.

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الطاقة الإنتاجية لمحاصيل المراعي في المملكة العربية السعودية

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المركز الإقليمي لأبحاث الزراعة والمياه - وزارة الزراعة والمياه - الرياض - المملكة العربية السعودية

تمت مقارنة القيمة الغذائية والطاقة الانتاجية لبعض الأعلاف المستوردة بعد زراعتها في المملكة مع محاصيل المراعي المحلية، ومن بين تلك الأعلاف وجد أن حشيشة البلوبانك (Blue Panic) وكلين (Klein) وحشيشة لف (Love grass) وحشيشة سجنل (Signal grass) هى الأكثر نجاحاً في عدد من المناطق ولكن وجد أن حشيشة البلوبانك تجاوزت الأصناف الأخرى من الناحية الإنتاجية وبلغ إنتاجها من ١٥٠ - ١٨٠ طن علف أخضر للهكتار في العام الواحد.

بلغت نسبة البروتين من ١٥ - ١٨٪ إضافة إلى أن البلوبانك شديدة التحمل للملوحة العالية حيث بلغ مدى تحملها ١٥٠٠٠ جزءً في المليون. ووجد أيضاً أن ٥٠٪ من كمية مياه الري التي يحتاجها البرسيم تكفي لري البلوبانك مما يدل على أن البلوبانك مقارنة مع محاصيل المراعي الأخرى هي الأكثر انتاجاً والأعلى قيمة غذائية والأكثر قابلية من حشيشة الرودس (Rhodes grass).