EVALUATION OF DIFFERENT EXOTIC GRASS SPECIES IN UPLAND BALOCHISTAN

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ABSTRACT

Eight cool-season and three warm-season exotic grass species were raised and evaluated for aboveground dry matter biomass in Mastung and Tomagh areas in upland Balochistan. Tall wheatgrass and pubescent wheatgrass exhibited high dry matter biomass in southern upland region (Mastung) both in fall, 1989 and spring 1990. In north-eastern region (Tomagh), weeping lovegrass outperformed in dry matter biomass production, however, some other species such as tall wheatgrass, pubescent wheatgrass, thickspike wheatgrass, orchardgrass and steppe wildrye also exhibited encouraging results. Mixture of Cool-season and warm-season grasses proved highly successful and showed promise to extend forage availability year round in upland Balochistan where winter forage deficit is a serious problem for livestock.

Key-words: Cool-season grasses, warm-season grasses, revegetation, livestock grazing, seed germination, dry matter biomass.

INTRODUCTION

Balochistan is the largest province of Pakistan comprising 34.5 million hectares (m.ha) of land. It is located in western part of Pakistan and shares its boundaries with Afghanistan in the north and Iran to the west (Rodriguez, 1994). Majority of the population derives its livelihood from livestock rearing. Balochistan province is distinctly divided into hot lowland and mediterranean upland regions.

Upland regions of Balochistan province experience mediterranean climate with predominantly winter precipitation. Overall mean annual precipitation is very low and it varies from 200 to 300 mm and supports extremely limited agricultural practices (Fig. 1). Only 4-5% of the total 34.7 m.ha area of the province is cultivated while almost rest of the area is regarded as rangelands (FAO 1993; Buzdar et al., 1984; Saleem, 1990). These rangelands support 11.3 million sheep, 7.4 million goats, 0.8 million cattle and 0.24 million camels (Rodriguez, 1994). Rangeland grazing is the major feed source of these animals as they derive almost 90% of their feed requirements through grazing (FAO, 1983). Due to undulating and moderate to severe topographical features of the region and partly because of inadequate availability of herbaceous forage, Balochistan livestock population is dominantly comprised of small ruminants. Increase in livestock population, particularly of small ruminants during the last decade, has resulted in severe problems of overgrazing and deterioration of natural vegetation. The southern upland region of the province is almost devoid of perennial grass component and animals are dependent only on slow growing shrubby vegetation of *Artemisia maritima* and *Haloxylon griffithii*. The north and north-eastern region, because of relatively high annual precipitation, provides good grazing grounds with a variety of grass-shrub mixed vegetation. Dominant grass species of this region are *Chrysopogan aucheri* and *Cymbopogan jwarancusa*. Increased grazing pressure has resulted in selective grazing of highly palatable *Chrysopogan* grass and a gradual increase in *Cymbopogan* cover (Saleem, 1990). With the continuous, yearlong grazing pressure, *Cymbopogan* is also declining and giving way to inherently slow growing and less palatable woody vegetation. This situation demands a quick response to restore the health of rapidly vanishing natural resource. The sparse plant cover in these deteriorated rangelands provide an opportunity to introduce new suitable forage species (Aro et al., 1989). In order to meet the immediate challenge of feed shortage for livestock and to improve range areas, Arid Zone Research Institute with the cooperation of International Center for Agricultural Research in the Dry Areas (ICARDA) arranged seeds of a number of exotic grasses for evaluation at two different locations in the province. The grasses were both of cool as well as of warm seasons (Table 1). These trials included eleven perennial range grasses. The primary objective of this study was to explore the potential of these exotic grass species for rehabilitation of arid rangelands of upland Balochistan.

MATERIALS AND METHODS

Study sites

Mastung is situated in the Kalat District, about 45 km south of provincial capital (29° 48' N latitude, 66° 50' E longitude, 1650 m elevation). The soils are silt loam (51.9% silt, 14.2% clay and 32.1% sand) with pH of 8.9 (Rees et al., 1989). Tomagh is situated in north-eastern region of upland Balochistan (30° 21' N latitude, 68° 36' E longitude, 1800 m elevation) in Loralai district. The soils are loamy clay texture containing rock fragments and derived from alluvial fan or terrace deposits (Aro et al., 1989; Wahid, 1990).

Eleven exotic grass species (Table 1) were raised during February, 1989 under rainfed conditions at the previously described two locations. The study, at each location, was laid out in completely randomized design with three replications. The grass species were considered as treatments. Seeds of each species were sown in 7 rows each having a row length of 5 m and row to row spacing of 0.25 m. Thus a plot size of 7.5 m^2 (5 m x 1.5 m) was maintained for each species. A seed rate of 250 seeds m^{-2} and a seeding depth of 2 cm was used in this trial (Vallentine, 1989). The aboveground biomass of plants, at both locations, was clipped at the time when they attained their full growth and set seeds (November 1989). The regrowth of same plants was again harvested at the end of spring season (June 1990). The entire plot under each grass species and under each replication was cut flush to the ground and green matter yield was recorded. Later on the samples were oven dried at 60° C for 48 hours and dry weight was recorded. The yield collected in this way in both the seasons and locations was projected on hectare basis and then the data were analyzed statistically using analysis of variance technique and means were separated with LSD (least significant difference) test (Steel and Torrie 1980).

RESULTS AND DISCUSSION

The aboveground biomass (hg/ha) is presented in Table 2. The results are described season-wise within a location in the following paragraphs.

MASTUNG

Fall season (November, 1989)

Tall wheatgrass gave the highest ($P<0.05$) (1890.0 kg/ha) dry matter yield

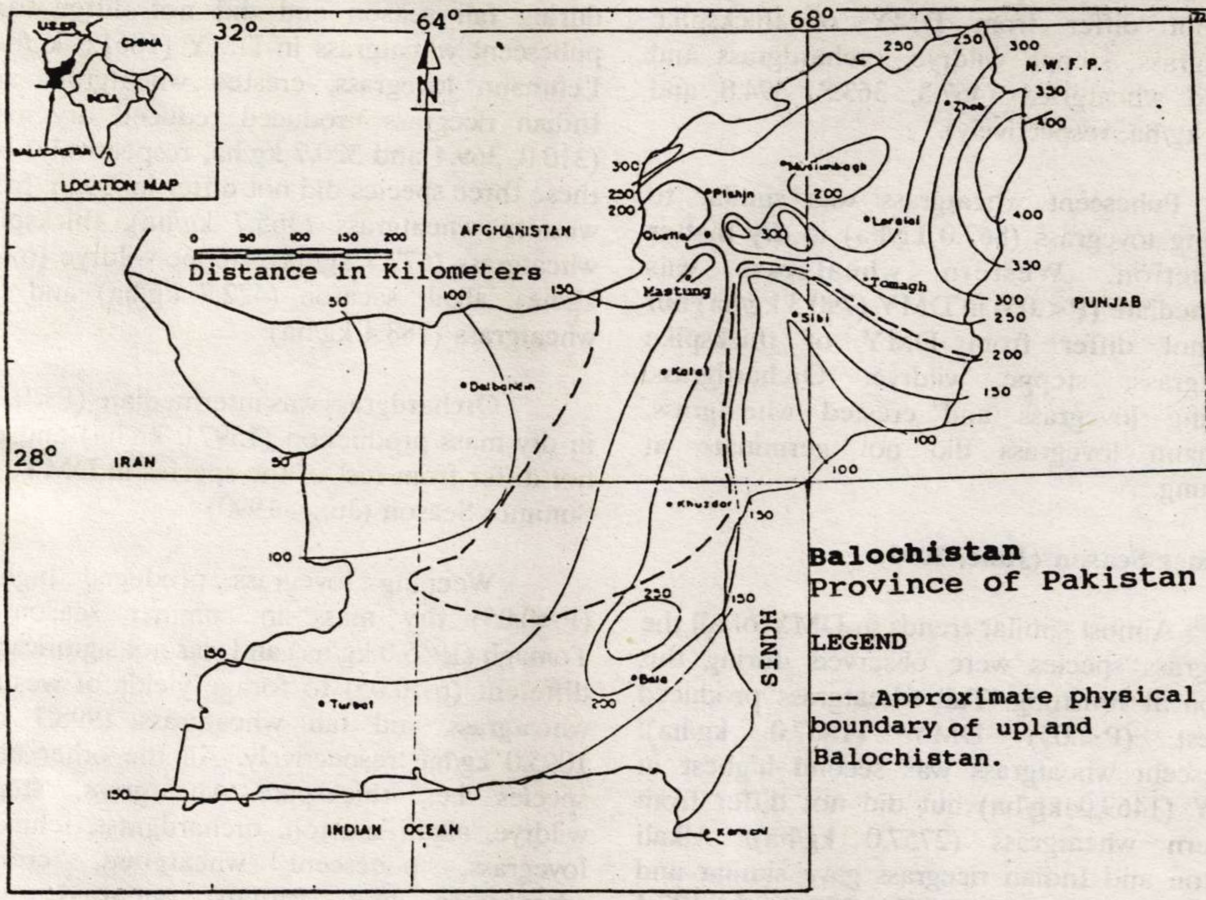

Figure 1. Geographical boundaries of Balochistan indicating location of study sites and average annual precipitation in millimeters (normalized on 1901-1940). Source: Rees et al. 1989.

(DMY) at Mastung during fall cutting that did not differ from DMY (1387.0 kg/ha) of pubescent wheatgrass. Alkali sacaton and Indian ricegrass produced similar and the reduced 155.3 and 16.0 kg/ha P<0.05) DMY respectively than all the other species but these two species did not differ from DMY of thickspike wheatgrass, steppe wildrye, orchardgrass and crested wheatgrass (467.3, 363.8, 394.8 and 348.5 kg/ha, respectively).

Pubescent wheatgrass was similar to weeping lovegrass (867.0 kg/ha) in dry matter production. Western wheatgrass was intermediate (P<.05) in DMY (790.3 kg/ha) but did not differ from DMY of thickspike wheatgrass, steppe wildrye. Orchardgrass, weeping lovegrass and crested wheatgrass. Lehmann lovegrass did not germinate at Mastung.

Summer Season (June, 1990)

Almost similar trends in DMY of all the ten grass species were observed during this season at Mastung. Tall wheatgrass produced highest (P<.05) DMY (1867.0 kg/ha). Pubescent wheatgrass was second highest in DMY (1469.0 kg/ha) but did not differ from western wheatgrass (2757.0 kg/ha). Alkali sacaton and Indian ricegrass gave similar and the reduced (P<.05) DMY (322.7 and 172.4 kg/ha, respectively) but these two species did not differ from DMY of thickspike wheatgrass (668.7 kg/ha), steppe wildrye (479.4 kg/ha), orchardgrass (1203.0 kg/ha), weeping lovegrass (1330.0 kg/ha) and crested wheatgrass (1246.0 kg/ha).

Western wheatgrass also did not differ in DMY from pubescent wheatgrass, steppe wildrye, orchardgrass, weeping lovegrass and crested wheatgrass.

TOMAGH

Fall Season (November, 1989)

At Tomagh, weeping lovegrass was at the top in dry matter production (4224.0 kg/ha) during fall season and did not differ from pubescent wheatgrass in DMY (1861.0 kg/ha). Lehmann lovegrass, crested wheatgrass and Indian ricegrass produced reduced dry mass (310.0, 369.4 and 320.7 kg/ha, respectively) but these three species did not differ in DMY from western wheatgrass (365.7 kg/ha), thickspike wheatgrass (677.7 kg/ha), steppe wildrye (690.7 kg/ha), alkali sacaton (422.7 kg/ha) and tall wheatgrass (788.4 kg/ha).

Orchardgrass was intermediate (P<0.05) in dry mass production (1597.0 kg/ha) and did not differ from rest of the species in DMY.
Summer Season (June, 1990)

Weeping lovegrass produced highest (P<0.05) dry mass in summer season at Tomagh (1945.0 kg/ha) and was not significantly different (p<0.05) to forage yields of western wheatgrass and tall wheatgrass (998.7 and 1095.0 kg/ha, respectively. All the other eight species i.e., thickspike wheatgrass, steppe wildrye, alkali sacaton, orchardgrass, lehmann lovegrass, pubescent wheatgrass, crested wheatgrass and Indian ricegrass gave significantly not different (p<0.05) DYM of 845.0, 490.0, 396.7, 934.0, 406.4 423.7, 265.4 and 557.0 kg/ha, respectively and these also did not differ from DMY of western wheatgrass and tall wheatgrass.

DISCUSSION

Revegetation of arid rangelands where annual precipitation does not exceed 600 mm is greatly influenced by the factors such as soil moisture and temperature conditions (Sigmund et al., 1966), availability of 'safe sites' in the seedbeds such as cracks or depressions (Harper et al., 1965), seeding rate and seeding depth (Plummer, 1943), intensity of competition among siblings at earlier stages of seedling development (Coyne and Bradford, 1965). Highly variable precipitation and extremes in temperature leave a major impact not only on seed germination but subsequent seedling establishment (Call and Roundy, 1991). Restoration of rangelands under such delicately balanced ecosystems is most difficult due to the constraints discussed above (Box, 1981). Upland Balochistan has a high risk environment where rainfall is highly variable both at temporal and spatial scales (Rees et al., 1989). Plant establishment by seeding, under such situations, is the dominant form of regeneration for most of the rangeland grasses (Saleem, 1990). A variety of C3 (cool-season) and C4 (warm-season) grasses were evaluated in this study primarily to explore the potential of extending forage availability for the livestock. The importance of suitable mixture of cool and warm-season grasses cannot be over-emphasized. A suitable mixture of such species can extend the forage availability on rangelands year round. Cool-season grasses provide forage during fall and early spring seasons when warm-season grasses are under dormant conditions (Nixon, 1949). Different grass species vary in their requirement for germination (Smolik and Johnson, 1968). Due to these differential requirements, species that yielded higher biomass at Mastung (tall wheatgrass) were different from those of high yielding grass species of Tomagh (weeping lovegrass). However, pubescent wheatgrass gave equally good results at both locations under both fall and summer seasons. Rest of the eight grass species performed at intermediate level and demand long-term evaluation under varying climatic conditions. Three of the four high yielding species discussed above are cool-season grasses while weeping lovegrass is a warm-season grass. Weeping lovegrass (*E. curvula*) has not only proved a high yielding grass species at Tomagh it can improve soil organic matter and water holding capacity. Covies (1960) has reported that in five years, the humus content of a plot cultivated with weeping lovegrass increased from 1.7 to 2.5% in the upper 5 cm soil depth. Soil moisture at 10, 30 and 80 cm was much higher under weeping lovegrass than under tall fescue (*Festuca arundianacea*), tall wheatgrass and alfalfa (*Medicago sativa*). This grass is also known for its nutritive value. Froseth (1970) reported 10.3% crude protein content of this grass. Balochistan rangelands where low quality range vegetation has resulted in poor nutritional status of livestock, grasses with high nutrient content are extremely important to be introduced.

During winter, when temperatures drop below 0° C at both locations (Wahid, 1990). cool-season grass species can withstand the winter vagaries and provide forage during this forage-deficit period. Kemph et al., (1976) reported similar results for crested wheatgrass and steppe wildrye in Texas.

Due to paucity of precipitation during growing season in upland Balochistan, it is imperative to evaluate such species which can withstand the hazards of drought. Some wheatgrasses such as thickspike wheatgrass and crested wheatgrass have the quality to persist under droughts (Currie and white, 1982). Generally, winter and spring precipitation wet the soil more consistently than the summer rainfalls and soil moisture from winter-spring precipitation remains for longer period of time (Clark and Calle, 1973). In areas like upland Balochistan, where winter precipitation dominates and most of the native grass species are under dormant condition, soil moisture is lost due to lack of proper cool-season grass. Cool-season grass under such situation can make productive use of winter and early spring moisture in these rangelands.

CONCLUSION

This was a short-term study evaluating the performance of different exotic grasses under a limited time span. Such studies are needed to be evaluated over a longer period of time and important variables such as fluctuating soil moisture and temperature conditions, root and shoot growth, inter and intra-specific competition, intensity of defoliation and nutritional status during different seasons of the year be monitored. In spite of lack of these observations, a preliminary study like this, yielded highly encouraging results. Degraded rangelands of Balochistan can be restored by introduction of proper grass germplasm and through careful evaluation. This process is slow and may take years to decades but potential is there.

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Table 1. List of exotic grass species evaluated for their aboveground dry matter biomass.

S.No.	Common Name	Botanical Name	Growth Requirements
1.	Tall wheatgrass	*Thinopyrum elongatum*	C3
2.	Pubescent wheatgrass	*Elytrigia intermedia*	C3
3.	Thickspike wheatgrass	*Elymus lanceolatus*	C3
4.	Western wheatgrass	*Pascopyron smithii*	C3
5.	Orchardgrass	*Dactylis glomerata*	C3
6.	Crested wheatgrass	*Agropyron desertorum*	C3
7.	Indian ricegrass	*Oryzopsis hymenoides*	C3
8.	Steppe wildrye	*Psathyrostachys juncea*	C3
9.	Weeping lovegrass	*Eragrostis curvula*	C4
10.	Lehmann lovegrass	*Eragrostis lehmanniana*	C4
11.	Alkali sacaton	*Sporobolus airoides*	C4

C3 = cool season grasses
C4 = warm season grasses

Table 2. Forage yield (kg/ha) of 11 exotic grass species raised in upland Balochistan.

		Locations			
			Mastung		Tomagh
S.No.	Grass species	Nov. 1989	June, 1990	Nov. 1989	June,1990
1.	Tall wheatgrass	1890.0[a]	8167.0[a]	788.4[bc]	1095.0[ab]
2.	Pubescent wheatgrass	1387.0[ab]	4169.0[b]	1861.0[ab]	423.7[b]
3.	Thickspike wheatgrass	467.3[cd]	668.7[cd]	677.7[bc]	845.0[b]
4.	Western wheatgrass	790.3[c]	2757.0[bc]	565.7[bc]	998.7[ab]
5.	Orchardgrass	394.8[cd]	1203.0[cd]	1597.0[abc]	934.0[b]
6.	Crested wheatgrass	348.5[cd]	1246.0[cd]	369.4[c]	265.4[b]
7.	Indian ricegrass	16.0[d]	172.4[d]	320.7[c]	557.0[b]
8.	Steppe wildrye	363.8[cd]	479.4[cd]	690.7[bc]	490.0[b]
9.	Weeping lovegrass	867.0[bc]	1330.0[cd]	2424.0[a]	1945.0[a]
10.	Lehmann lovegrass	-		310.0[c]	406.4[b]
11.	Alkali sacaton	155.3[d]	322.7[d]	422.7[bc]	396.7[b]

Means with the same letters in the same column do not differ significantly ($P<0.05$).