Salman IS, Barrett-Lennard EG, Kadhim K, Ismail S and Norman HC (2013). Salt-tolerant forages for irrigated saline land in central Iraq. *Proceedings of the 22nd International Grasslands Congress*, 15-19 September 2013, Sydney, pp. 1652–1654.

Salt-tolerant forages for irrigated saline land in central Iraq

Iman S Salman[A], Edward G Barrett-Lennard[B], Kareem Kadhim[C], Shoaib Ismail[D] and Hayley C Norman[E]

[A] Ministry of Agriculture, Baghdad, Iraq
[B] Centre for Ecohydrology, The University of Western Australia, Crawley WA 6059 Australia
[C] Ministry of Agriculture, Wasit, Iraq
[D] International Centre for Biosaline Agriculture, Dubai, UAE
[E] CSIRO Sustainable Agriculture Flagship, Private Bag 5, Wembley, WA 6913 Australia

Contact email: eman_sahib@yahoo.com

Abstract. Salinity is a major problem in the irrigated zones of central and southern Iraq. We investigated biomass production from five salt-tolerant forage species, represented by 15 introduced accessions and 3 local accessions, during two successive summer growing seasons. Species included pearl millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolour*), guar (Cluster bean; *Cyamopsis tetragonoloba*), cowpea (*Vigna unguiculata*) and sesbania (*Sesbania aculeata* and *S. sesban*). The research site was located in the Al-Dujaila irrigation project area in Wasit. The soil had a silty clay texture with moderate salinity (EC_e 10-20 dS/m). The site was irrigated with water (EC_w 1.1 dS/m) from the Tigris River on a 3 to 8-day basis. We hypothesised that there would be variation in biomass production, salt accumulation and crude protein both between and within species. In addition, we thought that the legumes would be less productive than grasses as they tend to be more sensitive to salinity. Over 2 experimental seasons, the plants produced an average shoot dry mass of 12.1 t/ha with a range for accessions of 3 to 35 t/ha. There was significant variation both within and between species, supporting the first hypothesis. None of the plants accumulated excessive salt (ash < 12% DM); crude protein was variable (6 to 12%), but higher in two legumes – cowpea and sesbania. Furthermore, there was no evidence that grasses were more productive than legumes, with sesbania and cowpea achieving the highest mean biomass production across the years. We conclude that moderately saline irrigated areas of Iraq can sustain high levels of biomass production for livestock although protein may be limited.

Keywords: Salinity, Iraq, biomass production, livestock.

Introduction

It is estimated that 19.5% of the world's irrigated agricultural land is salt-affected (Flowers and Yeo 1995; Ghassemi et al. 1995). The irrigated zones of central Iraq are no exception and it is estimated that salinity currently costs US $300 m/year in lost production and the problem is growing (Iraq Salinity Assessment 2012). The aim of these experiments was to explore the potential of summer crops (pearl millet and cowpea) and forages (sorghum, sesbania and guar) to provide feed for sheep and goats. We hypothesised that there would be variation in biomass production, salt accumulation and crude protein both between and within these species. Additionally, we thought that the legumes would produce less biomass than grasses as they tend to be more salt sensitive, although the biomass from legumes would have higher crude protein levels.

Methods

The experiment was located in the Al-Dujaila irrigation project area in Wasit on a private farm (32º25'N; 46º04'E). The soil had a silty clay texture (sand 15.2%, silt 36.4%, clay 48.4%) with mean salinity (EC_e) ranging between 10 and 18 dS/m across seasons and years (Table 1). Plots were sown on 17 May 2011 and 8 April 2012, in a randomized block design with 3 replicates per accession at the sowing rates in Table 2. The same site was used in the second year, but the plots were re-randomised. Each plot was a 9-m row with an irrigation furrow on each side. Adjacent rows were 35 cm apart. The species planted included 3 legumes; cowpea (2 genotypes), sesbania (2 genotypes) and guar (2 genotypes), and 2 grasses; pearl millet (8 genotypes) and sorghum (4 genotypes). Material was sourced from the International Centre for Biosaline Agriculture (Dubai); there was also 1 local sorghum genotype and 2 local pearl millet genotypes. During the growing periods, groundwater varied from 50 to 200 cm below the soil surface, with the salinity of the groundwater (EC_w) ranging between 19 and 70 dS/m (Fig. 1 and 2). The site was irrigated with water from the Tigris River (EC_w between 1.14 and 1.27 dS/m) on a 3 to 8-day basis with more frequent application during periods of high ambient temperatures. Over the growing season ~2 m^3 of water was applied per square meter of soil (Table 1). Species were fertilised differently, with N, P and K being applied at levels according to local agronomic best-practice recommendations (Table 2). Fertiliser intensity varied from no fertilisers for sesbania to sorghum with 200, 45, 80 kg/ha of N, P and K respectively. The fertiliser was applied in 3 portions, roughly a month apart. Aboveground biomass was harvested approximately 5 months after sowing on 13 October 2011 and 24 October 2012. After weighing, biomass replicates were bulked and analysed for ash content, total N (crude protein calculated as N*6.25) and K. All data were analysed by ANOVA using Genstat 15.

Table 1. Soil salinity at sowing and harvest, irrigation of salinity water and quantity of water applied.

Growing season	Initial soil salinity (EC_e dS/m)	Final soil salinity (EC_e dS/m)	Salinity irrigation water (EC_w dS/m)	Water quantity (m^3/m^2)	Number of irrigations
2011	18.0	13.0	1.14	1.98	25
2012	15.4	10.0	1.27	2.00	20

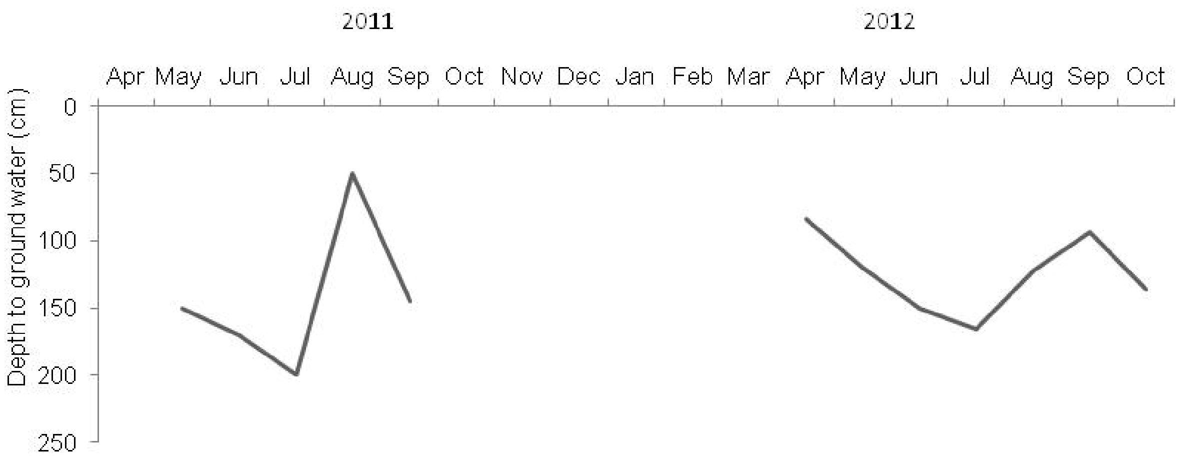

Figure 1. Mean depth to the ground water table (cm) at the experimental site during 2011 and 2012.

Results and Discussion

Mean biomass production across the 2 growing seasons ranged from 7.4 t DM/ha for pearl millet to 15.6 t DM/ha for Sesbania (Table 3). There were significant differences associated with species, years and a species by year interaction. The interaction is demonstrated by sesbania having relatively poor productivity in the first year and high productivity in the second season with guar having the opposite pattern (Fig. 3). The greater productivity of some species in 2012 may have been at least partly due to the longer growing season in this year. Three species (sesbania, cowpea and sorghum) were still green at harvest in 2012, but the other two species had ripened and stopped growing before harvest. There was no evidence that the grasses (sorghum and pearl millet) were more productive than legumes (cowpea, guar and sesbania) despite the relatively high fertiliser inputs for the grasses. The local pearl millet and sorghum genotypes were as productive as the introduced genotypes. As expected, the legumes generally had higher CP than the grass species; however, guar was not significantly higher than the grasses (Table 3; $P>0.05$). The 12% CP of cowpea and sesbania should be sufficient to meet the needs of mature, non-reproducing sheep or cattle (SCA 1990). However, protein supplementation indicates that they do not accumulate salt in a similar fashion to halophytic shrubs such as saltbush (Norman et al. 2013). This is ideal as salt has no energy value, restricts voluntary feed intake and can reduce digestibility of the diet (Masters et al. 2007). The potassium levels of the forages are not excessive (SCA 1990). Of all of the species tested, sesbania may represent the best economic value as it produced an average of 15.6 t DM/ha over two years with a CP of 12% without the need for fertilisers. Cowpea also showed promise. Biomass alone is not a good indicator of the value of plants in saline systems (Norman et al. 2013). Further investigation into the feeding value of these species is warranted; this includes voluntary intake, anti-nutritional factors as well as the opportunity to complement other feed sources to meet the nutritional needs of livestock in Iraq. Management of the plants should also be considered. For example, there is evidence that the nutritive value of sesbania forage is improved through increased cutting frequency (Al-Masri 2009). Where appropriate, the opportunity to use the plants for grain crops and forage should also be investigated. The legumes offer an advantage over the grasses as they provide an opportunity to fix biological nitrogen for subsequent cereal crops.

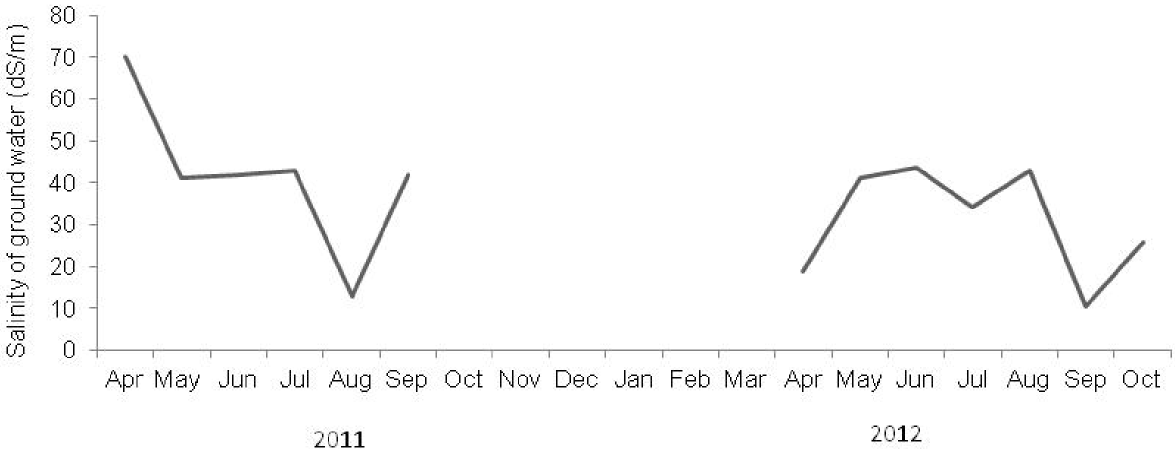

Figure 2. Mean salinity of the groundwater (EC_w; dS/m) at the experimental site during 2011 and 2012.

Table 2. Fertiliser composition and sowing rate (kg/ha). Fertiliser was applied in three portions each year.

Species	N	P	K	Sowing rate
Pearl millet	40	60	40	8
Sorghum	200	45	80	12-16
Guar	20	30	60	8
Cowpea	30	30	45	16
Sesbania	0	0	0	12

Table 3. Mean biomass production, crude protein, ash and potassium of the species over 2 growing seasons.

Trait	Species					Grand		Significance of differences[1]		
	Cowpea	Guar	Pearl millet	Sesbania	Sorghum	mean	SED	Species	Year	Species x year
Biomass (t DM/ha)	14.1	6.6	7.4	15.6	12.9	**12.1**	1.88	***	***	***
CP (%)	12.0	8.2	6.9	12.0	7.7	**9.4**	1.43	***	**	ns
Ash (%)	12.3	13.9	10.5	7.3	9.1	**10.6**	1.43	***	ns	***
K (%)	2.2	1.1	2.5	1.9	1.4	**1.8**	0.31	***	***	*

[1]* $P < 0.05$; ** $P < 0.01$; ***$P < 0.001$; ns is not significant

Conclusion

Salinity is a major constraint to agricultural production in Iraq. However, our study shows that moderately saline land should be regarded as being potentially productive, albeit for non-traditional crops. In our trial of summer fodder plants, many plants produced a considerable quantity of biomass (>10 t DM/ha) despite the salinity of the soil and irrigation water. There was significant variation both within and between species, in biomass production, ash accumulation and crude protein content. There was no evidence that grasses were more productive than legumes. None of the plants accumulated excessive salt (ash < 12% DM), and crude protein was variable (varied from 6 to 12%) with higher levels in two of the tested legumes. We conclude that moderately saline irrigated areas of Iraq can sustain high levels of biomass production for livestock although protein may be limited for breeding and lactating ewes, and feed supplements to overcome this deficiency will be required.

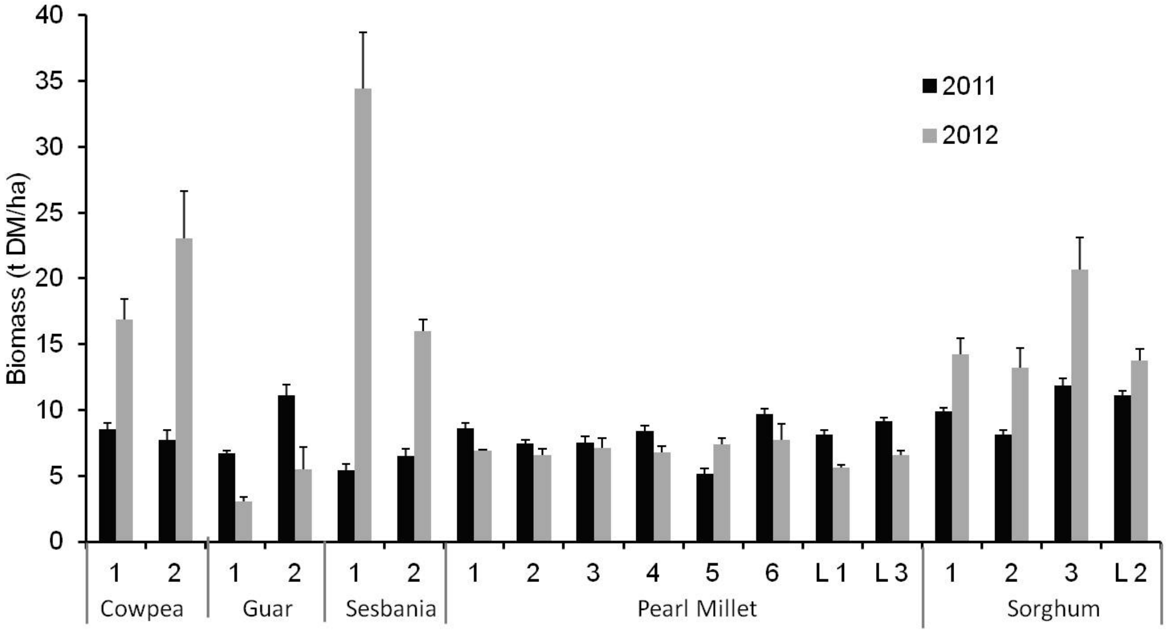

Figure 3. Biomass production (t DM/ha) of accessions in 2011 and 2012. Values are means of 3 replicates; the error bar is the SEM. Local genotypes are named with a 'L' prefix; other genotypes were from the International Centre for Biosaline Agriculture (Dubai).

Acknowledgements

We would like to thank ACIAR for funding (LWR/2009/034). Thanks are also extended to technical staff who assisted in measurements and analyses. Mohammed Jawad Al-Yassiry kindly hosted the research on his farm.

References

Al-Masri MR (2009) An in vitro nutritive evaluation and rumen fermentation kinetics of Sesbania aculeate as affected by harvest time and cutting regimen. *Tropical Animal Health and Production* **41**, 1115–1126.

Iraq Salinity Assessment (2012) Managing salinity in Iraq's agriculture, current state, causes and impacts. (International Center for Agricultural Research in Dry Areas). ISBN 92-9127-280-9.

Masters D, Rintoul A, Dynes R, Pearce K, Norman H (2005) Feed intake and production in sheep fed diets high in sodium and potassium. *Australian Journal of Agricultural Research* **56**, 427–434.

Norman HC, Masters DG, Barrett-Lennard EG (2013) Halophytes as forages in saline landscapes: interactions between plant genotype and their environment change their feeding value to ruminants. *Environmental and Experimental Botany* **92**, 96–109.

SCA (2007). 'Standing Committee on Agriculture's Nutrient Requirements of Domesticated Ruminants'. (CSIRO Publishing: Melbourne).