r,« J .lg!'l . .:Cl. rol. sots: ioo:

ADAPTATION AND PRODUCTIVITY OF ATRIPLEX IN PAKISTAN

J, Akhtar, R, H. Qureshi. M, Aslam and K,Mahmood
Salinc Agriculture Research Centre. University of Agriculture. Faisalabad, Pakistan

Harvesting or hushes during summer in trials or Atriplex project was associated with high plant mortalitics. However. it \\as not clear whether these deaths were caused by seasonal conditions. since no comparison was made with hand stripping in winter. This cxperimeut is to examine the effects of month of harvesting on the survival and productivity of.·ltl'i!)!l'\· *all/mm/a* and *Atriplcx lcnt f onnis*. The experiment had two species. Si" harvesting months (November. 1994, January. March. May. July. and September. 1(95) and four repl icates (ten plant /repl icate). The seedlings were allowed to establ ish for one year and after that scheduled harvesting up to pencil thickness were carried out. Fresh and dry weight of leaves and twigs and lcaf.tw ig ratio were recorded. Dry leaves were analyzed for Na. CL N and ash content. The soil had ECe of 16-37 dS m·. SI\R 20--=+X (mmol L 1)I'. and was silty clay loam. The ground water table fluctuated between 1.3-2.7 m. Months of harvesting had great impact on the survival and productivity of the species. Plant mortality was higher when harvesting was carried out during March to July and was 5-8 times greater in *A. lentiformis* than .1. *uninicola,* Re-sprouting (measured b) recording shoot volume two months after harvesting) was the highest in *A. !el1/ifol'mis* when harvested in July, In the case 01'.1. *atnniclbtt,* regeneration was greater when harvested in January or March. Shoot fresh weight was significantly higher in :L *untnicol a* for January and March. Leaf twig ratio of the forage. harvesting in January was higher in *A. cunnicola.* while forage of .1. *lentijorntis* was significantly more woody when harvested in January, Harvesting in March to July caused the maximum plant mortality.

Key Words: Auiplcx: Forage value: Harvesting time: Salt-affected soils: Saltbush: Pakistan

INTRODUCTION

Rcvcgctation or salt-affected wasteland with productive forage has considerable economic. environmental and social implications 111 developing countries. In Pakistan. about 6.3 mha of land are salt-affected. This includes 2.0 rnha of potentially highly productive abandoned salinc/sodic land in the canal command area. A large part of the salt-affected area of Sindh is not cultivated and is lying barren at present. Due to fine texture. these soils were not easily reclaimable. Rcclamability assessment of these soils by Rafiq (1975) showed that 2.A-+ mha are strongly saline soils (mostly containing gypsum) with severe problems, This category is apparently of wastelands as there is not enough irrigation water to reclaim these soils. In view of these circumstances. Saline Agriculture technology has a definite role to play in Pakistan. While. a number of grass species. forage shrubs and trees can be an option for these problem soils.

Saltbushes are widely grown on salt land for grazing and land rehabi Iitat ion (Barrctt-Lennard et al., 1986: Choukr-Allah et al. 19t)(l). However. growth of saltbush is variable. and is affected b) genetic and environmental factors such as salinity (Asl<1l11 et al., 1(86) waterlogging (Galloway and Davidson. 199 I) soil compact ion (Barrett-Lennard, 1991) and nutrient dcfic icncy (Lazarescu and Davidson. 1(91),

Earlier studies conducted on saltbushes *(Atrip!ex* species) under a range of environments in Pakistan (Qureshi et al., 1990: 199-+:Harrett-Lennard and Qureshi, 1994) have shown that *Atriple: uuuticol a* and *Atriplex lentiformis* have great potential for supporting livestock on wasteland with little requirements for irrigation (Mahmood et al., 19(3). Animal feeding trials on saltbush conducted in Pakistan and Australia have shown that harvesting twig of saltbush up to pencil thickness have high digestibility (Warren and Casson, 1991).

Although salt bushes have the potential to gnm on salt-affected lands under various agro-climatic (ones in Pakistan. their use by farmers as supplement fodder requires <In understanding of harvesting time because harvesting of bushes during summer in trials of ACIAR Project was associated with high plant mortalitics (especially at waterlogged soils), However. it was not clear whether these deaths were caused by seasonal conditions since 110 comparison was made with hand stripping in winter Accordingly the following study was conducted to examine the effects of month of harvesting on the survival an'd productivity of *A triples amnicol a* and *A triplex /1:l111(01'117* is

MATERIALS AND METHODS

The experiment was conducted with two spec ies *(.-l/ri/)/n amnicola* and *Atriplex lentifomnsi*. in a salt-affected field (silty clay loam: ECe 16-37 dS m', SAR 20--+8. Watertable depth 1,3-2,7m) at farmer's field near Satiana. The experiment was planted in Nov. 93 having four replication (ten plants/replicate) and six harvesting months (November. 1994. January, March. May. July and September. 19(5) The seedlings were allowed to establish for one year and alter that scheduled harvesting upto pencil thickness were carried out. Fresh and dry weight of leaves and twigs and leaf twig ratio were recorded, Dry leaves were analysed for Na . C!', N and ash contents, Oven dried leaf samples (0. I g) were ground and extracted with I ml, HNO, (I mol m') overnight. The extract was boiled in distilled water (6 ml.) for 15 minutes in a water-bath and supernatant transferred to 25 ml, volumetric flask. followed by two more extraction with distilled water.

Sodium and Chloride from the extract were determined by flame photometer, and Corning Cl^- Analyzer 925. respectively. Total N was determined by digesting the leaf in

sulphuric acid (Gumming and lIillbard method) and distilling on micro Kjeldahl apparatus (Jackson, 1(62),
Ash contents were determined by placing the weighed leaf sample at 550 oC in the furnace until they were converted into silver gray ash.

RESULTS

Leaf fresh weight

The leaf fresh weight (Fig. I) of two Atriplex species varied significantly with each other during all the harvesting months. The leaf fresh weight of *A. lentiformis* remained non-significant when compared for differing harvesting month and increased slightly during July harvesting, however, it was less than I kg plant compared to *A. amnicola* in which case leaf fresh weight was upto 4 kg plant during the March harvesting. Leaf fresh weight of *A. amnicola* increased progressively from November, 94 upto March 95 and then decreased sharply but significantly in May probably due to harsh summer weather.

Fresh twig weight

The fresh twig weight (Fig, 2) also followed the same pattern like leaf fresh weight and it varied significantly with all the harvestings between *A. amnicola* and *A. lentifortnis*. The maximum twig weight of *A. amnicola* and *A. lentiformis* was obtained during March and July, respectively. Fresh twig weight of *A. anmicola* increased progressively starting from November, 94 to March 95 and decreased sharply during May 95 and then increased during July and September harvesting. The fresh twig weight of *A. lentiformis* remain non-significant during the harvesting month and the change in weight was not sharp.

Tissue water content

When the water contents of leaves (Fresh.dry weight ratio. Table I) were considered *A/rip/ex «mnicolu* had higher water contents in leaves during January. while In *A.ientiforrnris*, higher water contents were found during July harvesting.

Leaf:twig ratio

The fresh leaf.twig ratio (Fig, 3) was higher in *A. atmnicola* than *A. lentiformis* during the harvesting months from November to May however. leaf twig ratio for both the species was almost same during July and it decreased during September for *A. amnico!a* as compared to *A. lentitorniis*. The comparison of harvesting months for individual species indicated that *A. amnicola* had the highest fresh leaf.twig ratio during March, while the lowest was observed during September. In case of *A. lentifortnis*, the highest ratio was found during March and May harvesting months.

Table I. Fresh.dry leaf ratio of *Atriplex amnicola* and *Atriplex lentiformis* as affected by harvesting month (Average of 4 replications ± S.D).

Harvesting month	Fresh:dry leaf Ratio	
	A/rip/ex amnicola	*A/rip/ex lentifonnts*
November, 1994	3,99 ± 0,34	3.65±0,18
January. 1995	6,04 ± 0,5	4.08 ± 0,32
March. 1995	4.35 ± 0,23	4.70 ± 0,34
May. 1995	4,37 ± 0,67	3.91±0.41
July. 1995	4,85 ± 0,42	5.27 ± 0.26
September. 1995	4.45 ± 0.23	3.52±0,16

Ionic Composition

The harvesting months did not affect the ionic composition of the leaves in respect of Na^+ and Cl^- (Table 2). Sodium concentration tended to increase with the age. for example, in *A. amnicola* Na^+ concentration during November 94 was 1.78 m.mol g^{-1} DW and during September. 95. it increased upto 3,47 m.mol g^{-1} DW, A similar trend was also observed for *A. lentiformis*. Chloride concentration were affected little (almost same for all the treatments) for both the species during different harvesting months.

Table 2. Ionic composition of leaves of *Atriplex amnico!a* and *Atriplex lentlformis* as affected by harvesting month (Average of 4 replications ± S.D).

Harvesting month	Na^+ m.mol g^{-1} dry weight		Cl^- m.mol g^{-1} dry weight	
	A. amnico!a	*A. lentifortnis*	*A. amnicola*	*A. lentitormis*
November, 1994	1,78 ± 0.12	2.00 ± 0.14	1,43 ± 0.05	1,33 ± 0.19
January. 1995	2.82 ± 0.17	2.72 ± 0,08	1.38 ± 0.15	1.24 ± 0, I I
March. 1995	2.84 ± 0.29	2.81 ± 0.37	1,41±0,05	1.35±012
May, 1995	2,63 ± 0,43	2,61 ± 0.10	1,25±0.07	1.11 ±O.IO
July, 1995	3.33 ± 0,49	4.02 ± 0.34	1,35 ± 0.32	11.5 ± 0.12
Septem ber, I995	3,47 ± 0,43	3.63 ± 0.79	1,45 ± 0.18	1.35 ± 0.06

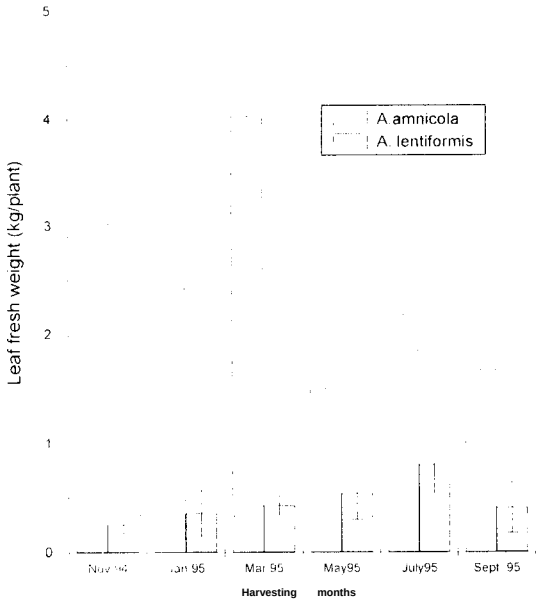


Fig. 1 Effect of harvesting months on leaf fresh weight of *A ammcola* and A *tentitormis*

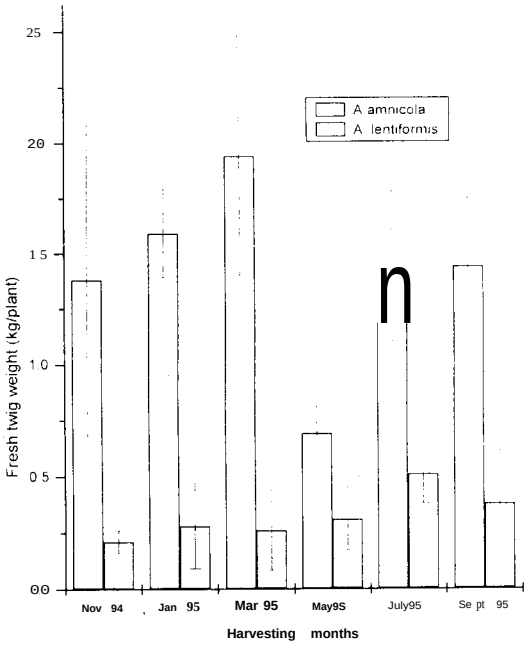
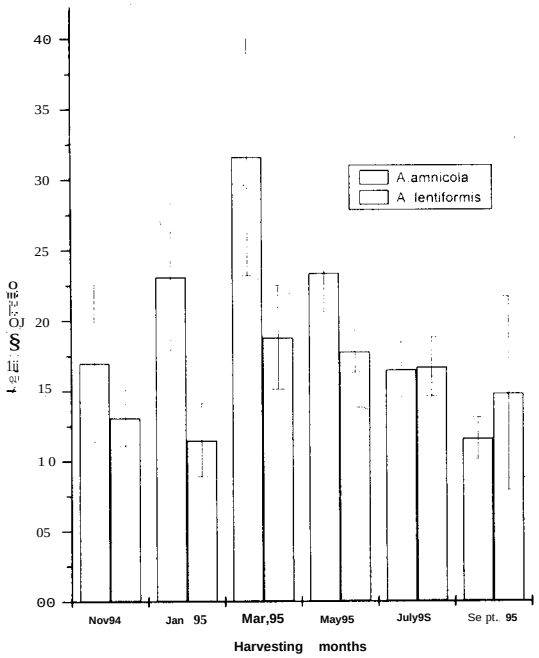


Fig.2 Effect of harvesting months on fresh tWig weight of A *emnicote* and A *lentiiormis*



Flg3 Effect of harvesting months on leaftwiq ratio of A *emnicole* and A *tentitormis*

Nitrogen Contents

Nitrogen contents in leaves of Atriplex species (Table 3) showed differences because of harvesting during different months. Nitroucn concentration in the leaves of .'/. aninica.la and .f. /enu/orlllll tended to improve with the harvesting month from November. 94 to March 95 while it decreased in both the species during May and July and increased slightly during September harvesting. with increasing age or time but the differences with time were non-significant in most of the cases.

Feeding trials on animals in Pakistan and Australia show that twigs of saltbushes upto a pencil thickness have a high digestibility as compared to thick ones (Warren and Casson. 1991). Therefore, harvesting of saltbush at a time when nc« growth have occurred would be more beneficial and profitable in terms of utilization by the animals. lhc previous studies also show less disorders in animal digestive system while consuming softer leaves and twigs of saltbushes than can be expected while consuming harder ones (Raza Ali: personnel communication). The maximum leaf.twig ratio was observed in case of March harvesting in both the species. This ratio was increased from November to March but declined afterwards. This trend shows the emergence of new leaves during the months from November to March while, leaf mortality or wilting and dropping during months from May to onward. This ratio of fresh leaves to twigs seems to be a good parameter of saltbush feed qual itv. Therefore. harvesting the saltbush in the month of March not only increased the yield but also the ked quality. Fortunately. the feed gap periods in Pakistan exist during the month of November and April., so these saltbushes have the ability to meet the feed gap requirements during these periods.

Table 3. Nitrogen and Ash contents of *Atrip/ex amnicola* and *Atriplex lentiformis* as affected by harvesting month (Average of 4 replications ± S.D).

l larvcsting month	Nitrogen (%)		Ash(Oo)	
	.1. OIIIIIICO/O	*.4. Icntitortnis*	*A. amnicola*	*.1. lvntitornris*
November. JJ)D4	O.52±0.IS	0.45±O.15	32,04 ± 1.52	31.92 ± 0.51
Januarv. 19')5	1.40 ± 0.06	1.63 ± 0.21	32.19 ± 2.58	325(l ±S5.
March. 1995	1.25±008	1.56±0.17	33,25 ± 3.04	36.69:t I.73
May. 1995	095±O.16	0.78±0.16	21.94 ± 2.0	20.75 ± 1.67
July. 1995	0.60 ± 0.07	0.51 ± 0.07	22.19 ± 1.15	22.94 ± 2.00
September. 1995	1.03 ± 0.,16	0.97 ± 0.08	22.56 ± 0.27	240()+ 1.99

Ash contents

Signilicant differences were observed in the case of ash contents in both the species during winter and summer months harvesting (Table 3). Ash contents in *A. atnnicola* and *A. lentltc.rnri»* were higher during November harvesting and increased slightly yet non-significantly during January and March harvesting. while it decreased significantly during May. Again ash contents increased slightly during July and September harvesting. Both the species had similar ash contents under all the harvesting treatment when compared with each other.

DISCIISSION

Growth and ionic composition of both the Atriplex species were affected by time of harvesting around the year. The variation in this regard was more conspicuous in case of *A/rip/cx amnicola* than in case of *Atriplex lentifonnis*. The two species varied significantly and *Atriples atnnicola* produced a signilicantly higher values for different growth parameters than the *Atrip!cx lentiformis*.

.//ri/ilc.r aninicol« produced the maximum fresh biomass (data not ShOII n) when harvested during the month of March while the minimum was produced in case of May harvesting. A similar trend was also observed in case of most of the other growth parameters except fresh leaftwig ratio. The reason could be a sudden rise in temperature during the month of April that caused leaf mortality and permanent wilting of twigs. A decrease in growth due to high temperature has also been reported by Gupta, (1997).

In contrast to *.itriplex amnicola*.. *-itriplcx lentiformis* gave the maximum biornass production in terms of different growth parameters when harvested in the month of July. Also, it ShOIIS a consistent increase in harvested biomass

Many farmers now consider saltbush as an invaluable fodder reserve. As well as being available as a green fodder during: periods when other feed is in short supply. saltbush leaves contain higher levels of nitrogen than pasture grasses do. Also, the saltbushes provide substantial fodder from unproductive lands particularly during periods of acute shortage of conventional fodders. In Pakistan, annual fodder requirements of animals are 63 x 10(>tons and fodder deficit is about 40% (Hanjra and Rasool, 1993) with acute fodder shortage from April to June. Present study show a higher nitrogen content and higher leaf Twig ratio of saltbushes during the months of January and March. It shows that in January to March, saltbushes can supplx softer good qual it) fodder with high nitrogen contents. It wouk] be better for farmers. therefore, to harvest this fodder in these months, store it and use in coming months of acute fodder shortage.

A negative aspect of saltbush fodder, as common with other halophytic plants., is salt accumulation in its tissues to cope with moisture and salt stress. This high salt content reduces its feed value (Warren and Casson, 1(94) as it affects the animal health and leads to increased water uptake (Warren and Casson. /9(1).

Therefore. animal diet must also include a fodder with a low salt. content (Warren et al., 1(90). However, stock grazing animals , have shown a selection of saltbushes from associated grasses to balance their salt intake (Casson and Warren, 19(4) . Present study show that chloride contents are not increased significantly with time. However. . sodium concentration has shown a significant increase from January to September. . l:arlier Schulz (1996) have also reported an irregular trend in sodium concentration with time. Therefore, the problem of higher salt. concentration in saltbush is not manageable by changing the harvest time rather it will require a mixing with other fodders.

ACKNOWLEDGEMENTS

Authors are highly grateful to Australian Centre for International Agricultural Research (ACIAR) for funding ACIAR Project (n02 to conduct these studies.

REFERENCES

Aslarn. /.,. W. D. Jcschke and E.G. Barrett-Lennard. 1986. Effects of external NaCI on the growth of *A/rip/ex aninicola* and the ion relations and carbohydrate status of the bill'S . Plant Cell and Environ. 9:571-580.

Harrcu-l.cnnard. , l.Ci. 199 I. Maximizing production of *.urtpl c»* species, pp. 90-93 . In: N../. Davidson and R. Gallowav, cds .. Productive use of Saline Land. ACIAR Proceedings. -+2, Canberra, Australia.

Barrert-Lennard. I;.G. and R.II. Qureshi. 1994. Using salt land in Pakistan-An Australian Connection. W.A.J. . Agri.35:95-98.

Harrett-Lcnnard. FCi., C.V. Malcolm, W.R. Stern and S.M. Wilk ins. 1986. Forage and Fuel production from salt-affected 1\ :istcland. Elscvier Sci. Publ, Amsterdam.

Casson. T. and [3.13. Warren. 1994. Monitoring the diet of sheep grazing revegetated saline land, pp. 130-133. In: Proc 3'" National Workshop on Productive Use 'of Saline Land. March 1994, Echuca.

Choukr-Allah. R.. C.V. Malcolm and A. Hamdy. 1996. Ilalophytes and Biosaline Agriculture. Marcel Dekker, New York.

Gallo\\;IY. R. and N.J. Davidson. 1991. The interactive effect of salt and warerlogging on .--*trip/ex amnicota.* pp. I 12-114. In: N.J. Davidson and R. Galloway, eds., Productive use of Saline Land. ACIAR Proceedings. 42, Canberra. Australia.

Gupta. US 1997. Crop Improvement Vo1.2. Stress tolerance. Oxford and **IBH** Publishing Co. Pvt. Ltd. New Delhi, India.

Hanjra, S. H. and S. Rasoo!' . 1993. Potential of *Atriplex* as a forage for Livestock in Pakistan, pp. 68-70. In: N.J.Davidson and R.Galloway, eds .. Productive use of., Saline Land. ACIAR Proceedings. 42, Canberra, Australia.

Jackson, M.L.. 1962. Soil Chemical Analysis. pp. 183-192. Constable and Co. Ltd .. London ..

Lazarescu, G. Land N.J. Davidson. 1991.. Nitrogen concentrations for optimal growth of *Atriplex aninicola*,. pp. 98-99. In: N.J. Davidson and R. Galloway, eds .. Productive use of Saline Land. ACIAR Proceedings. -+2, Canberra, Australia.

Mahmood. T., R.H. Qureshi, M. Aslam and M. Qadir. 1993. Establishment and growth of *A/rip/ex amnicola* planted in different season and at different heights on the sides of raised banks, pp. 104-106. In: N.J.. Davidson and R. Galloway, eds., Productive use of Saline Land. ACIAR Proceedings. 42, Canberra. Australia.

Qureshi, R.H., M. Aslam, S. Nawaz and 1'. Mahmood. 1990. Saline Agriculture Research in Pakistan. pp. 409-423. In: Proc. lndo-Pak Workshop on Soil Salinity and Water Management. .. PARC. Islamabad, Pakistan.

Qureshi, R.H ., S. Nawaz, M. Aslarn, LA. Mahmood and A. Asad. 1994. Performance of selected *Atriplex* and *Marieana* species in Punjab, Pakistan. Pp. 503-526. In: Advance Course on Halophyte Utilization 111 Agriculture. Agadir, Morocco.

Rafiq, M. 1975. Saline, Saline-alkali and waterlogged soils of the Indus Plain-their characteristics. causes of formation and measures needed for reclamation. Pp.308-32. In: Proc. of the International Conference on waterlogging and Salinity, 13-17 October 1975 Univ Engg. Tech. Lahore. Pakistan ..

Schulz, M. 1996. Management options for reducing the ash content of Atriplex. In: Forage shrub production from saline and or sodic soil in Paksitan-Z. Ann. Report 1995-96. ACIAR Project 9302. Canberra, Australia.

Warren, B. and T. Casson. 1991. Saltbush quality and sheep performance. pp. 71-74. In: N.J. Davidson and R. Galloway, eds., Productive use of Saline Land. ACIAR Proceedings. 42, Canberra, Australia.

Warren. B.E. and T. Casson. 1994. Sheep and saltbush are they compatible, pp.125-129. In: Proc. ofthe Productive Use of Saline Land. 3rd National Workshop, March. 1994, Echuca.

Warren, B.E .• C.J. Bunny and E.R. Bryan. 1990. A preliminary evaluation of the nutritive value of four saltbush *(A/rip/ex)* species: Proceedings of the Australian Society of Animal Production 18:424-427.