Preliminary Observations on the Performance of Some Exotic Species of *Atriplex* in Saudi Arabia

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Abstract

Seeds of seven different *Atriplex* species (four from the United States and three from Australia) were germinated in the greenhouse and then transplanted to field plots at the Regional Agriculture and Water Research Center (RAWRC), located at Riyadh, Saudi Arabia. Data were obtained on vegetative growth, flowering, seed production, seed germination, and chemical composition of the plants. There were marked differences between species in vegetative growth. All flowered normally, but seed production and seed germination percentages differed among the species. All species were high in protein and ash content. Further field studies are underway at different sites within the Kingdom to test the potential value of *Atriplex* for the improvement of Saudi Arabian rangeland.

In most arid regions of the world, extreme conditions of high temperature and soil salinity restrict plant growth and development. Such conditions occur widely in Saudi Arabia, where vast expanses of land are only sparsely vegetated and have very low carrying capacity. The genus *Atriplex* includes species which might be adapted to such marginal land. Satisfactory forage production by *Atriplex* species under similarly harsh environmental conditions has been reported for Australia, United States, and Africa (McKell et al. 1968). The present study investigated the growth and chemical composition of seven exotic species of *Atriplex* growth in field plots at the Regional Agriculture and Water Research Center located near Riyadh, in central Saudi Arabia.

Material and Methods

Seeds of the seven *Atriplex* species were imported for experimentation. *Atriplex polycarpa, A. muelleri, A. canescens,* and *A. halimus* were obtained from Dr. L.R. Green, range scientist, Forest Fire Laboratory, Riverside, California, and *A. rhagodioides, A. nummularia,* and *A. inflata* from Mr. C.V. Malcolm, research officer, Department of Agriculture, Perth, Western Australia.

Seeds of each species were sown in the greenhouse in November, 1976, in earthern pots (30 cm in diameter and 12 cm deep) containing 1:1 mixture of sand and peat. Pots were watered regularly to keep the surface moist. All species had completed germination within 1 month.

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When large enough to be handled conveniently, individual seedlings were transferred to separate containers (12 cm diameter and 6 cm deep) having the same mixture of sand and peat. After 3 weeks in the greenhouse, these plants were transplanted to the field plots beginning in January, 1977.

Seedlings ranged from 12 to 16 cm in height at this time. The transplants were placed 1.75 meters apart, in rows which were 2 meters apart, and irrigated immediately after transplanting. Thereafter, plants were irrigated regularly to maintain their growth and development. From 7 to 15 plants of each species were thus transplanted.

Growth was measured in terms of the height and diameter of the plants. Observations on flowering and fruit setting were recorded. Seed germination studies were carried out. Leaves were collected and analysed for ash and crude protein by standard methods.

Results

Vegetative Growth

The best criterion of growth would have been the total yield of forage produced by each species. In the present experiment, however, the objective was to collect seeds for future use, and so the plants were permitted to grow undisturbed to encourage seed production. Mean heights and diameters of the plants were recorded and used as measures of vegetative growth (Table 1). *Atriplex nummularia* had the greatest average plant heights and diameters. Next was *A. rhagodioides,* followed by *A. halimus* and other species. The growth parameters used in the present study do not provide an entirely satisfactory basis for ranking the performance of individual species. However, it was satisfying to note that the statures of some plants after 1 year's growth were not greatly different from those reported in their native place (Beadle 1952).

Flowering

Dates of flowering of all species are shown in Table 1. Earliest flowering occurred in *A. inflata.* Actually, this species flowered in April, 2 1/2 months after transplanting, then flowered and produced fruits again in October of the same year. This response may be an important one, increasing its chance for survival and propagation.

Seed Set

The intensity of seed set was judged visually and in arbitrary terms (Table 1). *Atriplex inflata, A. mulleri,* and *A. rhagodioides* were the most prolific seed producers. *Atriplex canescens* showed least seed set, whereas *A. nummularia* and *A. polycarpa* were intermediate. Surprisingly, no insect damage to seed was noted in any of the species. Polymorphism was noted in *A. rhagodiodes* and *A. nummularia:* In both species clusters of male and female flowers were produced separately, either on the same or on different plants. Also, some fruits in these two species lacked fully developed seeds, probably due to lack of fertilization.

Seed Germination

Germination was studied in seeds of all species except *A. canescens* and *A. nummularia.* First, the effects of temperature on germination were determined; the optimum temperature for germination of all species was between 15° C and 20° C. When bracts were removed from seeds of *A. inflata* prior to germination, germination increased from 60% to 95% (Table 1).

The highest germination percentage was found in *A. inflata* (with bracts removed), followed by *A. mulleri* and *A. halimus* (without bracts removed). Post-harvest dormancy occurred in *A. polycarpa* and *A. rhagodioides.*

In *A. polycarpa,* the seeds did not germinate despite the many techniques tried (hot and cold treatment, leaching, acid treatment or scarification). On dissecting the seeds, it was noted that the embryos were weakly developed. Perhaps the climatic conditions in Saudi Arabia induced sterility, because in its native California *A. polycarpa* seeds germinate readily, immediately after harvest (Chatterton and McKell 1969).

Chemical Composition

(a) Ash: Ash contents ranged from 17% to 27% (Table 1). These levels are within the ranges reported for Australian salt bushes (Beadle 1952) and *Atriplex canescens* in the United States (Welch 1978). Ash contents of plants on different sites would be expected to vary if the soils differ in salinity. In this study, though, the soil was relatively uniform; therefore, the differences in ash contents probably reflected genetic differences between species as well as differences in degree of succulence of harvested materials.

(b) Protein: Protein ranged from a low of 11.1% in *A. inflata* to a high of 18.8% in *A. polycarpa* (Table 1): It is known that protein levels in *Atriplex* vary seasonally e.g., in *A. canescens* crude protein has been reported to range from 7.8% to 24.2% (National Academy of Science 1958).

Discussion

The logic for investigating *Atriplex* species as potential introductions to improve Saudi Arabian rangeland lies in their perennial habits, deep root systems, salt and drought tolerance, high nutritive value, and persistence. Cultivation of some of these species in the United States (Goodin and McKell 1970) and in Australia (Malcolm 1969), gave results suggesting that some of these species may be useful on marginal lands in Saudi Arabia where prolonged drought and excessive salinity are common.

It is encouraging that seven exotic species in this study grew normally and produced flowers and viable seeds (except for *A. polycarpa*). These results warrent further studies to test species performance under a variety of stresses common to different regions of the Arabian Peninsula. The next stage in the program was initiated in January, 1979, when nine species of *Atriplex* were planted under nonirrigated conditions at Oatif in Eastern province of the Kingdom. They are being observed for potential use as

Table 1. Data showing growth, germination and chemical composition of *Atriplex* species in RAWRC field plots on January 15, 1978.

Name of species	Transplanting date	No. of plants	Mean height (cm)	Mean diameter (cm)	Flowering[1] date	Seed set	Germination (%)	Ash (%)	Protein (%)
Atriplex polycarpa	29.1.77	12	80	75	8.11.77	Medium		17.0	18.8
A. muelleri	8.1.77	15	35	130	11. 5.77	Prolific	90	21.0	12.0
A. canescens	24.1.77	15	90	120	7. 8.77	Poor		18.8	13.0
A. halimus	1.3.77	13	100	120	10.11.77	Low	40	26.7	17.3
A. rhagodioides	29.1.77	3	70	250	13. .2.78	Prolific	Dormant	22.8	14.6
A. nummularia	7.2.77	15	180	200	12.12.77	Medium		27.2	16.3
A. inflata	29.1.77	7	40	180	18. 4.77	Prolific	95(without bracts) 60 (with bracts)	23.5	11.1

[1]Dates when plants had shown 50% of the total flowering.

forage resources of the Eastern province.

In addition to the field experiments, we are also using laboratory and greenhouse facilities to study the physiological responses of *Atriplex* species to specific factors related to salinity, drought, and high temperature.

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