

Shrub Transplanting for Range Improvement in Iran

NASSER NEMATI

Highlight: Of three saltbushes tested under the harsh environment of the Central Plateau of Iran, fourwing saltbush (*Atriplex canescens*) was the most adapted. Transplanting in October and November when transplants were about 20 to 30 cm high was the most promising practice. Although the cost of transplanting when compared with other revegetation practices is high, the chances of success are also high, and production per hectare can be increased at least three-fold within a 4-year period.

In the United States and Australia, saltbushes (*Atriplex* spp.) are important sources of winter forage for livestock and wildlife. Through the years various species of saltbushes have been seeded numerous times by ranchers and public agencies. It has been amply demonstrated that establishment of shrubby species by direct seeding is full of uncertainties. This is specially true in arid and semiarid zones of Iran because, when soil moisture is likely to be adequate, temperatures often are either too high or too low, and when temperatures are near optimum soil moisture is often deficient. Research results indicate that transplanting of saltbushes is more satisfactory than reseeding in harsh environments (Plummer et al. 1966).

Studies of native stands in the United States have indicated that fourwing saltbush (*Atriplex canescens*) grows under a wide range of environmental conditions, withstands drought, heat, cold, and provides palatable, nutritious forage throughout the year. More than 40 years ago the importance of fourwing saltbush was recognized, but attempts to establish the plant were frequently unsuccessful. The main problem in reseeding of this species is slow germination. Much needs to be learned about factors that influence germination (Springfield 1972).

Recently, fourwing saltbush has been used in watershed restoration work on alluvial flood plains of the Rio Puerco drainage in New Mexico. It also is being used to trap sediment above flood detention structures, thereby prolonging the useful life of the structure. Establishment of plant cover behind these structures will also enhance wildlife values (Aldon 1972).

Since reseeding in lower elevations of the Central Plateau of Iran is almost impossible due mainly to unfavorable climatic and edaphic factors, shrub transplanting has been considered the most promising method of revegetation. Three introduced saltbushes, *Atriplex canescens*, *Atriplex lentiformis*, and *Atriplex halimus*, have been successfully established in some areas by transplanting. The study reported in this paper was con-

ducted to obtain some information about methods of producing planting stock of *Atriplex canescens*, *Atriplex lentiformis*, and *Atriplex halimus* and methods of transplanting nursery grown plants to the field, comparative cost, relationship of transplant height to percent survival, and productivity analysis.

Study Areas

Studies were made on three sites in the steppe zone of the Central Province of Iran. Descriptive data for the three sites are presented in Table 1.

During the spring growing season, much of the precipitation falls as light showers that are not effective for plant growth or as high intensity storms from which the moisture is lost by run-off from the poorly vegetated slopes. High winds of several days duration are common. Temperature changes are frequently sudden. In the winter and spring, several warm days may induce germination and growth may be followed by freezing temperatures that kill the seedlings. These characteristics make spring growing period of perennial species extremely difficult.

In general, soils are calcareous and gypsiferous very fine sandy clays, loams, or clay loams. Most soils are extremely low in organic matter and have poor structure. Development of a vesicular surface layer is common to most soils.

Textural and chemical analyses were made using samples from three locations within the Yazdan Range, because this area was considered to be representative of the three areas studied (Table 2). Data presented represent an average for all depths (5, 10, 15, 20, 25, and 30 cm) at each location. The data illustrate the heterogeneity that exists within a relatively small area. Samples 1 and 2 characterize soil found throughout most of the area. Sample 3 is from a saline clay soil common in this zone.

Wherever human influence is minimal, natural vegetation is composed of strongly rooted perennial grasses, semishrubs, and shrubs. Perennial and annual legumes and a large number of perennial and annual species of other families are present. This vegetation provided abundant valuable forage.

Over-exploitation has resulted in the disappearance of most of the perennial forage species over vast tracts of land. The remaining vegetation thus consists of species with low forage value and those which could best survive due to their particular life forms.

Table 1. Characteristics of the three study areas.

Name	Location from Tehran (km)	Area treated (ha)	Elevation (m)	Annual ppt. (mm)
Zarand-Saveh Range	45 west	1000	1320	205
Yazdan Range	100 south	1000	1070	170
Karizak Range	25 south	1000	1056	200

The author is Deputy Director General of Range Management Department of Iran. Manuscript received July 28, 1976.

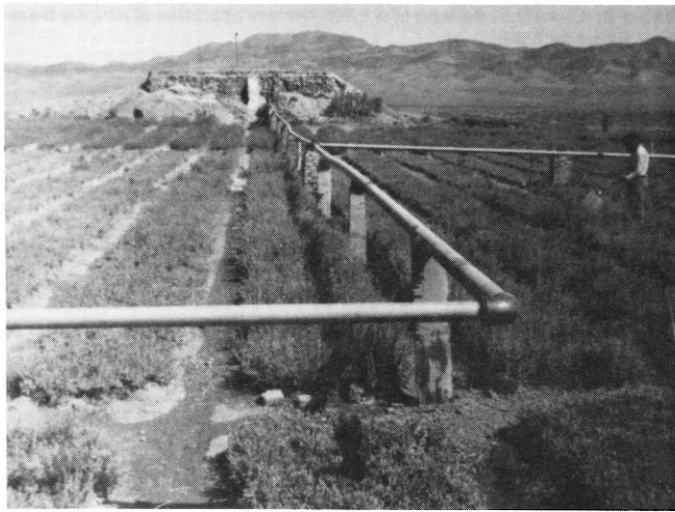


Fig. 1. *Atriplex* nursery at Zarand-Saveh Station.

Methods and Procedures

Effect of Time of Transplanting of Bareroot and Bagged Plants on Plant Survival

Three-month-old seedlings of each of the three species from nurseries (Fig. 1) adjacent to each site were transplanted in prepared contour furrows. Transplanting was done at 15-day intervals from June until December. Planting was by hand labor. Bareroot plants and bagged plants were transplanted. Evaluation of treatment (bagged vs bareroot; season of transplanting) was based on data obtained from 600 single plant observations for each treatment.

To permit roots to extend from plastic bags, 2 to 3 cuts were made on the sides of bags at the time of transplanting.

Contour furrows were spaced at 4 m and the distance between plants along the contour was 3 m. Seedlings were irrigated at the time of transplanting.

Transplant Height and Survival Study

During 1972-73 we determined the effect of height of *Atriplex canescens* transplants on survival. Ten transplants in each of 10 furrows were selected at random and labeled. Height was measured and recorded. Survival data were compared with transplant height classes.

Production Study

In the fall of 1972, herbage production of the 1968 plantings at Darizak was determined for *Atriplex canescens* and for native species (Fig. 2). Square-meter clip plots were located at 10-m intervals along a randomly located transect. Twig growth of the current year of *Atriplex canescens* and associated native shrubs and standing crop of grasses

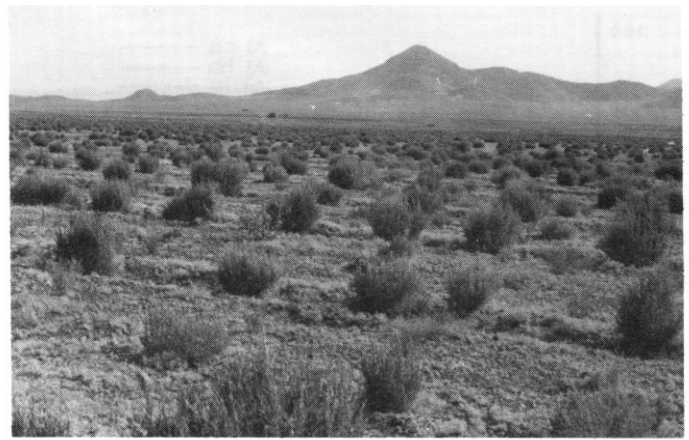


Fig. 2. Karizak Range 4 years after transplanting of *Atriplex canescens*.

and forbs for each plot were clipped, air dried, and weighed. Data obtained were used to calculate the carrying capacity of treated and untreated range. Statistical confidence intervals (95%) were determined for the production data.

Cost of Transplanting

Cost of transplanting on a per hectare basis was determined for a large scale transplanting operation, including costs of labor, material, and equipment. Equipment cost for contour furrowing was estimated on a rental basis; depreciation costs were charged for owned equipment.

Result and Discussion

Transplant Survival in Field

Percent survival as related to different planting dates of bagged and bare root transplants at Zarand-Saveh Range, which is typical at all sites, is shown in Figures 3 and 4. On a transplant time basis, percent survival of all species at the three sites had the same pattern. Maximum survival varied from site to site between June, July, August, and December transplanting. Maximum survival of *Atriplex halimus* and *Atriplex lentiformis* was from September plantings. In general, survival of bagged and bare root *Atriplex canescens* transplants was higher than the two other species at all three sites. Peak survival of bagged transplants was almost 85% for *Atriplex canescens* and for bare root transplants was almost 45%. Maximum survival of bagged *Atriplex halimus* and *Atriplex lentiformis* was about 40% and for bare root was about 25%. Survival of *Atriplex halimus* and

Table 2. Chemical and textural analysis of soils from Yazdan Range which is a typical soil of the Steppic Zone of Iran.

Analysis ^a	Soil sample		
	1	2	3
pH	8.8	8.7	8.9
P ₂ O ₅ (ppm)	20	8	10
Ca (ppm)	34,500	34,400	30,000
Na (ppm)	445	385	19,500
K (ppm)	45	25	30
Soluble salts (EC _e × 10 ³)	.77	0.63	2.2
Organic matter (%)	0.10	0.12	0.12
Sand (%)	73	87	17
Silt (%)	17	9	27
Clay (%)	10	4	56

^aAnalyses made by the soil laboratory of Alborz Research Center.

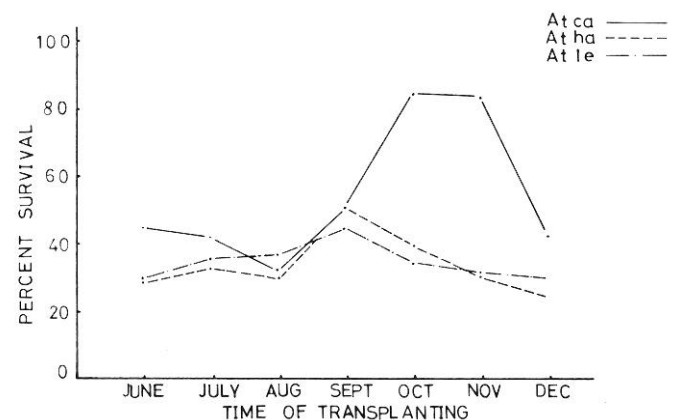


Fig. 3. The average percent survival of plastic bag transplants recorded in 1971 and 1972 from Zarand-Saveh. (At ca = *A. canescens*, At ha = *A. halimus*, At le = *A. lentiformis*.)

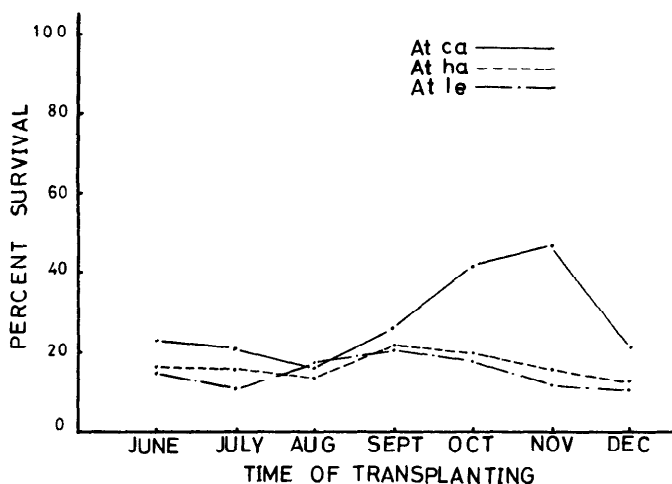


Fig. 4. The average percent survival of bare root transplants, recorded in 1971 and 1972 from Zarand-Saveh. (Atca = *A. canescens*, Atha = *A. halimus*, Atle = *A. lentiformis*.)

Atriplex lentiformis varied only slightly through time at the three sites. An increase in survival of bagged transplants began with August transplanting and continued to get better until the best survival rates were obtained from September for *Atriplex halimus* and *Atriplex lentiformis* and from October and November for *Atriplex canescens* transplanting, after which survival again declined.

Transplant Height and Survival

There was a relationship between height of transplants and percent survival (Fig. 5). Percent survival was low when transplants were 5 cm high. With an increase in height, percent survival increased. The best survival was obtained from transplants of 20 to 30 cm height at time of transplanting.

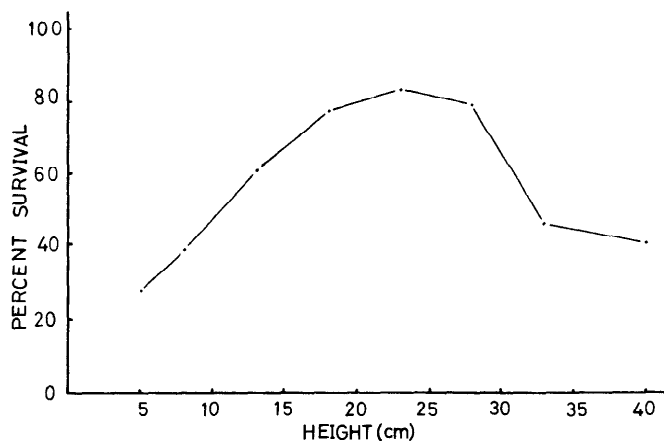


Fig. 5. The relationship between height of *Atriplex canescens* transplants and percent survival at Zarand-Saveh.

Production

Mean production (kg/ha) for the treated and untreated area was 508 kg and 150 kg. Statistical confidence intervals for the transplanted area were from 335 to 680 kg and for the non-transplanted area were from 125 to 179 kg. Even though there was considerable variation in production within the transplanted area, the difference in production between treated and non-treated areas was highly significant.

Table 3. Cost (U.S. dollars) of a 1,000-hectare operation of *Atriplex* transplanting in Iran.

Item	Amount	Cost/unit	Total cost (1,000 ha)
Plastic bags	4,500 kg	\$1.00/kg	\$ 4,500.00
Manure	250 m ³	5.71/m ³	1,427.50
Sand	800 m ³	3.57/m ³	2,856.00
Contour furrowing and diking	1,000 ha	2.31/ha	2,310.00
Raising and transplanting seedlings	1,000,000	—	58,500.00
Depreciation of equipment (3 tractors, 5 water-tanks, 3 disk plows, and 2 trailers)	—	—	3,142.86
Total			72,736.36
Cost/ha			72.74

Because production of native and transplanted species was combined to obtain total production, the increased yields from the treated area can be attributed to yield from the introduced shrubs plus the increased production at native species.

Increase in production of native species was due to changes in the microclimate. Change in microclimate can be expected from: (1) protection, (2) irrigation of transplants at time of the transplanting, and (3) wind effect decreased for understory vegetation as height of transplants increased.

Cost

Total cost of a 1,000-hectare operation of transplanting is shown in Table 3. The total cost of 1,000 hectare was estimated at \$72,736, which resulted in a cost of \$72.74/ha. These figures apply to operation in the Central Ostan only. In general, the cost will be lower in most other provinces.

Conclusions

The conclusions were as follows:

1. In the Central Plateau of Iran, the best time to transplant *Atriplex halimus* and *Atriplex lentiformis* is September; October and November are best for *Atriplex canescens*.
2. The best survival will be with transplants 20 to 30 cm in height.
3. Plastic bag transplanting is more successful than bare root transplanting.
4. *Atriplex canescens*, as compared to *Atriplex halimus* and *Atriplex lentiformis*, is the best adapted shrub species to be transplanted in the Central Plateau of Iran.
5. The total production per hectare can be tripled (from 150 kg to 400 kg) within a maximum 4-year period by transplanting *Atriplex*.
6. The cost of transplanting *Atriplex* was estimated as \$72.74/ha on a large scale basis. The costs are relatively high in comparison with other range rehabilitation practices, but the chances of success also are higher.

Literature Cited

- Aldon, E. F. 1972. Critical soil moisture levels for field planting fourwing saltbush. *J. Range Manage.* 25:311-312.
- Plummer, A. P., S. B. Monsen, and D. R. Christensen. 1966. Fourwing saltbush—a shrub for future game range. Utah State Dep. Fish and Game Pub. No. 66-4.
- Springfield, H. W. 1972. Using mulches to establish woody chenopods. U.S. Dep. Agr., Forest Serv. Gen. Tech. Rep. INT-1.