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# Chemical Fertilization of Fourwing Saltbush

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**Highlight:** *Fourwing saltbush is an important member of arid and semiarid rangeland communities, supplying high quality forage for herbivores as well as serving as an erosion deterrent. Methods of saltbush establishment, however, have met with only limited success. Results of a greenhouse study show that small additions of balanced fertilizer can greatly increase saltbush growth and hence likely increase the probability of saltbush establishment. The results appear to warrant further study in the form of field tests to evaluate the practicality of large scale fertilization of saltbush plantings.*

Fourwing saltbush (*Atriplex canescens* (Pursh) Nutt.) has long been recognized as an important member of arid and semiarid rangeland communities. It provides high quality forage for herbivores and serves as an important erosion deterrent. Among the most palatable of Southwestern shrubs, fourwing saltbush is cropped by all classes of livestock (Judd, 1962), while wildlife utilize it for cover, roosting sites, and food (Van Dersal, 1938). It has high nutritional value, which is maintained during the winter months (Cook et al., 1959).

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Mature fourwing saltbush plants are commonly 1 to 2 m tall, with stems freely branching above the ground surface. The extensive root system of fourwing saltbush may penetrate 5 to 15 m into alluvial soils, making the plant very drought resistant and well suited to erosion control (Van Dersal, 1938). Establishment of fourwing saltbush on overgrazed or otherwise abused rangeland may, therefore, have the duel economic function of restoring rangeland for livestock and wildlife utilization as well as providing limited erosion control.

Direct seeding of saltbush has generally resulted in very poor establishment. In part this has been due to low seedling emergence and poor survival of seedlings in the field (Springfield, 1970; and Cable, 1972). Field plants have been established using greenhouse stock, but transplanting of stock from a natural stand failed (Cable, 1972). Springfield (1970) increased seedling survival through the use of mulches and also increased transplant survival by germinating and growing plants in soil taken from under mature saltbush growing in the field. Williams (1972) showed that this increased survival was in part due to beneficial endomycorrhizal fungi present in the soil.

The purpose of this investigation was to determine what effect small additions of a balanced 12-12-12 fertilizer had on the growth of fourwing saltbush.

## Materials and Methods

Three soils were used in this study. The names *under, between*, and *garden* will be used hereafter to refer to these soils. The *under* sample was collected from immediately under the fourwing saltbush canopy, whereas the *between* soil was collected between the saltbush plants at least 6 feet away from the nearest plant. A distinction was made between soil collected from under the saltbush and soil collected between plants because of a suspected mycorrhizal fungi infestation of soil immediately under the plants. Mycorrhizal populations have been shown to increase nutrient availability for some plants. *Garden* soil was collected from a private garden in the Albuquerque area and had been heavily fertilized for a number of years.

The *garden* soil was classified as the calcareous Gila clay loam, which is a member of the coarse-loamy, mixed, thermic family of Typic Torrifluvents. Bulk samples of the soil were collected 3.2 km west and 16 km south of the Federal Building in Albuquerque. The *between* and *under* soils were classified as the Las Lucas loam and were members of the fine-silty, mixed mesic family of Ustollic Camborthids. Samples were collected 3.2 km south of La Ventana, N. M., and 2.4 km due east of San Luis, N. M., just east of state highway 44 at the old Civilian Conservation Corps camp.

Approximately 180 kg of each soil type was collected from the top 15 cm of the profile. The soils were air dried and stored in metal garbage cans at room temperature. The soils were mechanically ground and larger chunks of organic material, soil aggregates, and rocks were removed.

The effect of small additions of fertilizer on the growth of saltbush was studied under greenhouse conditions. Thirty-six pots (diameter 23 cm and height 18.5 cm) were divided into three groups of 12 pots. Each group was filled with one of the three soils (about 7.2 kg of soil/pot). One gram of 12-12-12 fertilizer, equivalent to 22.8 kg N/ha, 10 kg P/ha, and 18.75 kg K/ha, was added to each of six pots from each group. The remaining six pots in each group constituted the control (no fertilizer) treatment. Seeds (100 per pot) were planted in a ring 3 cm from the outside of the pot and 1 cm below the soil surface. The fertilizer was banded about 2 to 2.5 cm immediately below the seeds.

The pots were randomly oriented in the greenhouse and watered 26 times with a total of 12.1 cm of water during the 97-day growth period, resulting in a favorable moisture regime for the seedlings. The locations of the 36 pots were randomly changed 20 times during the growth period to minimize temperature and light differences within the greenhouse.

Twenty-three days after emergence, all plants were thinned to nine plants per pot. Plants were thinned again at the end of another 43 days to maintain a population of nine plants per pot (only plants which had germinated since the first thinning were removed).

At the end of 97 days, plants were harvested, dried at 75°C for 14 days, and weighed.

## Results and Discussion

The average dry weights of plants were not significantly ($P$ = 0.05) different for saltbush grown on any soil when all soils were fertilized (Table 1). However, plants grown on the unfertilized *under* and *between* soils yielded significantly ($P$ = 0.05) less than plants grown on the unfertilized *garden* soil. The addition of fertilizer to either the *between* or *under* soil resulted in significantly ($P$ = 0.05) greater yields when compared to the

Table 1. Average yield (mg) of plants per pot grown on *under, between,* and *garden* soils. Weights are for the aboveground portions of the plants only.

| Treatment | Soil[1] Between | Under | Garden |
|---|---|---|---|
| Fertilized | 174.8 a | 149.3 a | 135.2 a |
| Unfertilized | 72.5 b | 85.8 b | 138.6 a |

[1]Yield values followed by the same letter in any column or row were not significantly different ($P$ = 0.05). Significance was determined using the student $t$ test.

unfertilized soils, whereas the *garden* soil was unaffected by fertilizer application. The *garden* soil was reported to have been heavily fertilized in the past and was, therefore, not expected to respond to small additions of fertilizer. Small additions of fertilizer to the *between* and *under* soils resulted in yields that were not significantly different from the yields obtained on the heavily fertilized *garden* soil. Crusting observed in the clay loam *garden* soil (but not in the *between* or *under* soils) may have affected the yield of saltbush in these pots.

There was no difference in yield between the unfertilized *between* and *under* soils, indicating that any mycorrhizal effect on nutrient availability in the *under* soil was negligible. The additions of fertilizer had a much more pronounced effect on yield on either the *between* or *under* soil than did the mycorrhiza found to be present in the *under* soil.

Yields from the fertilized *between* and *under* treatments were pooled and were found to be significantly ($P$ = 0.001) different from the pooled yields for unfertilized *between* and *under* treatments. Yields due to fertilizer were about 100% greater than yields for unfertilized pots indicating the potential for increasing saltbush growth and hence the probability of establishment with the use of fertilizer.

## Conclusions

The experiments described herein were conducted in the greenhouse under favorable moisture and temperature conditions, and hence probably maximized the fertilizer effect. Anderson (1972), for example, observed no significant response in mean leader growth of saltbush to the application of 252.5 kg N/ha in the field. Variation within treatments was large, however, and effective moisture was only 55% of normal during the year of Anderson's work, which would probably reduce any fertilizer effect. No phosphorus or potassium was applied with the urea used in Anderson's study and only leader growth was measured rather than total plant weights.

The large yield increases observed in this study appear to warrant continued study into the effects of fertilizer on saltbush establishment. Field studies in which different rates and types of fertilizer are applied should provide more conclusive evidence as to the practicality of facilitating large scale saltbush establishment with fertilization.

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# Ungulate Diets in the Lower Grand Canyon


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**Highlight:** *Plant fragments were identified and quantified by a microscopic examination of the dung of the burro, cattle, and bighorn in the western end of the Grand Canyon, Arizona. Genera of plants common to the diets of all three ungulates were:* Sphaeralcea, Bromus, Tridens, Muhlenbergia, Acacia, Ephedra, Opuntia *and* Tidestromia. *Wherever free ranging large herbivores occur, as in the Lake Mead National Recreation Area, it is possible to study their diets by analysis of their dung. The diet of modern large herbivores can be compared with the unique Pleistocene record of ground sloth and extinct mountain goat dung preserved for over 11,000 years in adjacent caves.*


Many innovative methods of determining diets in wild and domestic herbivores have been used in recent years. One such


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