Relationship of Saltbush Species to Soil Chemical Properties

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Abstract

The relationship of pure stands of 6 saltbush species to sodium adsorption ratio, electrical conductivity, and alkalinity are documented. The data gathered were obtained while correlating soils to range sites for National Cooperative Soil Surveys. Soil scientists gathered detailed soil information and obtained lab data. Range conservationists correlated the saltbush species to specific soils and by using lab data made a direct relationship to pure saltbush stands. Species ranked from highest to lowest adaptability to SAR, EC, and pH are: mat saltbush *(Atriplex corrugata* S. Wats.), mound saltbush *(A. obovata* Moq.), Castle Valley clover *(A. cuneata* A. Nels.), sickle saltbush *(A. falcata* (M.E. Jones) Standl.), shadscale *(A. confertifolia* (Torr. & Frem.) S. Wats.) and fourwing saltbush *(A. canescens* (Pursh) Nutt.). By knowing the SAR, EC, and pH tolerances of these 6 species, interpretations for inventorying, rating plant community potentials, and applying range improvements will be achieved with greater success.

Key Words: ***Atriplex communities, soil analysis (chemical), saltbush adaptability, soil-plant relationships***

Salt-desert shrub communities of the Intermountain West cover some 16 million ha of rangeland within the Great Basin Desert (Holmgren and Hutchings 1972). Studies have been conducted for more than 70 years on the description and ecology of salt-desert shrub communities (Billings 1945, 1949; Blaisdell and Holmgren 1984; Blauer et al. 1976; Fautin 1946; Hutchings and Stewart 1953; Kearney et al. 1914; Shantz and Piemeisel 1940; Singh 1967; Stewart et al. 1940; Tiedemann et al. 1984; Vest 1962; Wagner and Aldon 1978; West and Ibrahim 1968; and Wood 1966). Many of these salt-desert plant communities are in pure stands of single species while others occur as a mixture of species.

There are many factors that develop the often distinct boundaries of salt-desert plant communities. West (1982) attributes this to the fact that the salinity and aridity tolerance levels of various species cause a sorting effect along a moisture and salinity gradient. Branson et al. (1967) observed soil-moisture relationship and soil salts as the primary cause of different plant communities. In western Utah, Gates et al. (1956) established differences between soils and salt-desert plants, but concluded that no specific soil factor limited each species range as there was an overlap of the soil factors measured. However, there were different amounts of salt and sodium between the soils of each species. Billings (1949) found salt-desert shrub soils to have carbonates accumulating just below the surface and the presence of salts in the subsoil.

Saltbush species have been studied along with other salt-desert plants in relation to soluble salts, sodium, pH, and other soil characteristics (Blauer et al. 1976; Hansen 1962; Naphan 1966; Welch 1978; and West and Ibrahim 1968). However, correlation of species directly to sodium adsorption ratio (SAR), electrical conductivity (EC), and alkalinity (pH) is lacking. The purpose of this study was to document the relationship of 6 saltbush species to SAR, EC, and pH on the soils where they occurred as the dominant shrub in pure stands.

Study Area and Methods

The study was conducted while correlating soils to range sites in cooperation with National Cooperative Soil Surveys. The sample sites within the soil surveys are located in northeastern Arizona and northwestern New Mexico as shown in Figure 1.

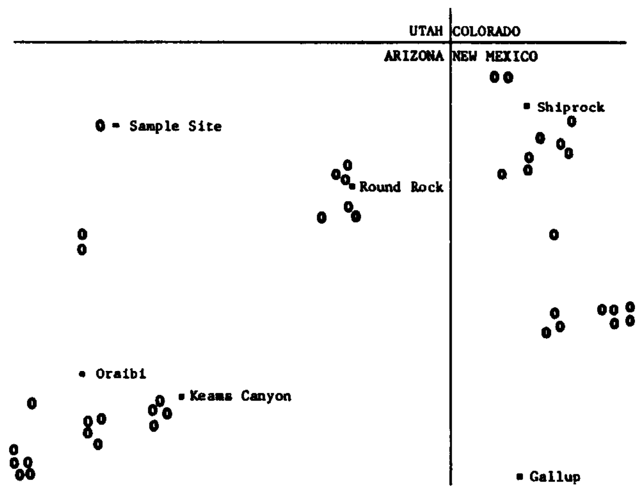

Fig. 1. *General location of sites sampled in northeastern Arizona and northwestern New Mexico.*

The climate is arid and semiarid. Average annual precipitation ranges from 13 to 25 cm with a great variation from year to year. About 55% of the moisture occurs during the fall-winter-spring months. Forty-five percent occurs as summer thundershowers from moist tropical air from the Gulf of Mexico. Winds occur in the spring and usually precede the summer storm fronts. Elevations range from 1,463 to 1,859 m.

During the soil mapping process, soil scientists gathered detailed soil profile descriptions and soil samples for analyzing chemical properties and assisting in classifying the soil. The samples were sent to the Bureau of Indian Affairs soils lab in Gallup, N. Mex., or the Soil Conservation Service National Soil Survey Laboratory, Lincoln, Neb., for analysis. From the lab reports, the SAR, EC, and pH were obtained.

At each soil sampling location, the saltbush species present were recorded. The 6 species identified in the study area were fourwing saltbush (*Atriplex canescens* (Pursh) Nutt.), sickle saltbush (*Atriplex falcata* (M.E. Jones) Standl.), Castle Valley clover (*Atriplex cuneata* A. Nels.), mat saltbush (*Atriplex corrugata* S. Wats.), mound saltbush (*Atriplex obovata* Moq.), and shadscale (*Atriplex confertifolia* (Torr. & Frem.) S. Wats.). Soils having similar characteristics and a corresponding plant community were grouped together. Using the lab data, the SAR, EC, and pH values were compared and correlated to each saltbush species. In a sodic soil, the SAR indicates the sodium amounts that affect soil properties and may interfere with plant growth. A high EC in a saline soil contains soluble salts that may interfere with plant growth. A pH value of 7.4 or more indicates an alkaline soil.

Results and Discussion

During soil surveys, soil scientists and range conservationists work together in correlating and grouping soils to range sites. A main purpose for this correlation of surveys on rangeland is to aid in interpretations of the soil capabilities and vegetation potentials for use and management. It was during this correlation process

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The author thanks the soil scientists at Flagstaff, Ariz.; Shiprock, N. Mex.; and Ft. Wingate, N. Mex., for their assistance with the soils data. Also, thanks to Dr. Howard C. Stutz, BYU, Provo, Utah, who provided identification of *Atriplex falcata* (M.E. Jones) Standl.

Manuscript accepted 9 June 1986.

that it became apparent that pure stands of saltbush with associated species occurred on soils each having distinct chemical characteristics.

Naphan (1966) reported the most important soils occurring in the salt-desert shrub ecosystem were of the Aridisols and Entisols orders within the National System of Soil Classification. The soils sampled in the study area are of the Aridisols and Entisols orders. All species of saltbush occurred in both orders and sometimes occurred in the same family and subgroups. However, there was a distinct difference in the SAR, EC, and pH of the soils that corresponded to the pure stands of each saltbush species (Table 1).

A summary of each saltbush species depth, position on the landscape, and associated plants; and the soils sodicity, salinity, and alkalinity (Fig. 2) follows:

Mat saltbush occurred on moderately deep and deep soils on hillslopes, ridges, footslopes, knolls, and toeslopes of undulating plateaus. It was always the dominant plant species. Other plants present in minor amounts were alkali sacaton (*Sporobolus airoides* (Torr.) Torr.), Indian ricegrass (*Oryzopsis hymenoides* (Roem. & J.A. Schultes) Ricker Ex Piper), and bottlebrush squirreltail (*Sitanion hystrix* (Nutt.) J.G. Smith). The soils were moderately to strongly sodic; slightly to strongly saline; and moderately to strongly alkaline.

Mound saltbush occurred on deep soils on alluvial fans, stream terraces, and fan terraces. The major plants associated with mound saltbush in order of dominance were: alkali sacaton, galleta (*Hilaria jamesii* (Torr.) Benth.), bottlebrush squirreltail, and western wheatgrass (*Agropyron smithii* Rybd.). Black greasewood (*Sarcobatus vermiculatus* (Hook.) Torr.) and ribscale (*Atriplex powellii* S. Wats.) were sometimes present. The soils were moderately to strongly sodic; very slightly to moderately saline; and moderately alkaline.

Castle Valley clover occurred on moderately deep and deep soils on toeslopes below mesas and cuestas, and small benches of undulating plateaus. Associated plants in order of dominance were Indian ricegrass, alkali sacaton, galleta, and sand dropseed (*Sporobolus cryptandrus* (Torr.) Gray). The soils were slightly to moderately sodic; very slightly to moderately saline; and moderately to mildly alkaline.

Sickle saltbush occurred on shallow soils on knolls and footslopes below cuestas and low mesas. Associated plants in order of dominance were alkali sacaton, Indian ricegrass, galleta and minor amounts of hairy coldenia (*Coldenia hispidissima* (Torr. & Gray) Gray). The soils were slightly sodic; slightly saline; and moderately to mildly alkaline.

Shadscale occurred on very shallow, shallow, moderately deep, and deep soils on fan terraces, hillslopes, and undulating plateaus and structural benches. Galleta was the dominant associated plant. Others were alkali sacaton, Indian ricegrass, and bottlebrush squirreltail. The soils were slightly to moderately sodic; non-saline to slightly saline; and moderately alkaline.

Fourwing saltbush occurred on deep soils on alluvial fans and stream terraces. Associated plants in order of dominance were Indian ricegrass, galleta, bottlebrush squirreltail, western wheatgrass, and Greene rabbitbrush (*Chrysothamnus greenei* (Gray) Greene). The soils were slightly sodic; non-saline to very slightly saline; and mildly alkaline.

Conclusions

Each saltbush species has adapted to certain soil chemical properties. During the soil mapping-plant community correlation process, management units can be established which will identify those species most adapted to each unit.

By knowing the SAR, EC, and pH tolerances for the 6 species, interpretations can be made as to suitability of sites for a particular species.

By matching the saltbush to its adapted SAR, EC, and pH, a higher quality of management can be expected. Range management techniques will be achieved with greater success, whether it be a grazing system, seeding or other range improvement project.

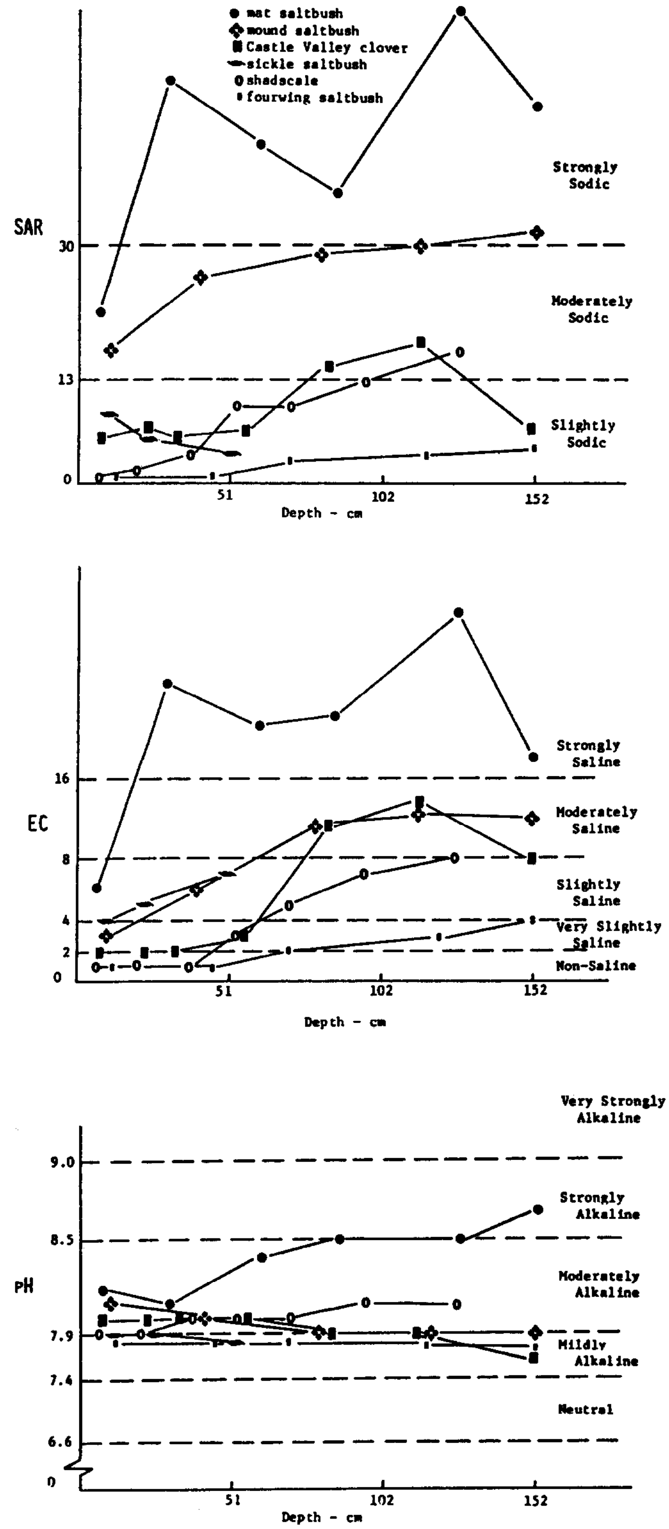

Fig. 2. *The relationship of 6 saltbush species to SAR, EC, and pH.*

Specific data on SAR, EC and pH tolerances should be very useful in reclaiming disturbed areas where the values of these factors are believed to be high enough to influence normal plant establishment and growth. Data on tolerance values should be

Table 1. Composite of soil samples taken for each species.

No. of Samples	Species	Soil Family and Subgroup	Depth cm	SAR avg	EX×10³ avg	pH avg
5	Mat Saltbush	fine, mixed (calcareous),	0–8	22	6	8.2
		mesic Typic Torriorthents	8–30	62	28	8.1
			30–61	46	23	8.4
		fine-silty, mixed (calcareous),	61–86	37	24	8.5
		mesic Typic Torriorthents	86–127	83	37	8.5
			127–152	57	19	8.7
32	Mound Saltbush	fine, montmorill-ontic, mesic	0–10	17	3	8.1
		Typic Natrargids	10–41	26	6	8.0
		fine-loamy, mixed (calcareous),	41–81	29	10	7.9
		mesic Typic Torrifluvents	81–114	30	12	7.9
			114–152	32	11	7.9
		fine-loamy, mixed mesic, Typic Camborthids				
		fine-loamy, mixed, mesic, Typic Natrargids				
		fine, mixed, mesic Typic Camborthids				
10	Castle Valley Clover	fine-silty, mixed (calcareous),	0–8	6	2	8.0
		mesic Typic Torriorthents	8–23	7	2	8.0
			23–33	6	2	8.0
		coarse-silty, mixed (calcareous) mesic Typic	33–56	7	3	8.0
		Torriorthents	56–84	15	10	7.9
		coarse-silty, mixed, mesic	84–114	18	13	7.9
		Typic Camborthids	114–152	7	8	7.6
		fine-silty, mixed, mesic Typic Camborthids				
7	Sickle Saltbush	loamy, mixed (calcareous),	0–10	9	4	7.9
		mesic, shallow Typic	10–23	6	5	7.9
		Torriorthents	23–51	4	7	7.8
18	Shadscale	fine-loamy, mixed, mesic	0–8	1	1	7.9
		Typic Haplargid	8–20	2	1	7.9
		fine, mixed, mesic Ustollic	20–38	4	1	8.0
		Haplargid	38–53	10	3	8.0
		fine-loamy, mixed, mesic	53–71	10	5	8.0
		Haplic Natrargids	71–97	13	7	8.1
		coarse-loamy, mixed, mesic Calcic Gypsiorthids	97–127	17	8	8.1
		fine-silty, mixed mesic Typic Camborthids				

Table 1. Continued

No. of Samples	Species	Soil Family and Subgroup	Depth cm	SAR avg	$EX\times10^3$ avg	pH avg
15	Fourwing Saltbush	coarse-loamy, mixed (calcareous) mesic Typic Torriorthents	0–13	1	1	7.8
			13–46	1	1	7.8
			46–71	3	2	7.8
		sandy over loamy, mixed (calcareous) mesic Typic Torriorthents	71–117	4	3	7.8
			117–152	5	4	7.7
		fine-loamy, mixed, mesic Ustollic Camborthids				
		fine-loamy, mixed, mesic Typic Camborthids				
		coarse-loamy, mixed mesic Typic Calciorthids				

especially valuable to those involved in mine reclamation efforts.

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