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## FORAGE SHRUB ADAPTION TRIALS AT THREE PINYON-JUNIPER SITES

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Agricultural Research Service  
UNITED STATES DEPARTMENT OF AGRICULTURE  
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FORAGE SHRUB ADAPTATION TRIALS AT  
THREE PINYON-JUNIPER SITES

By Fred Lavin and Thomas N. Johnsen, Jr.<sup>1</sup>

SUMMARY

Initial growing season results of an adaptation study entailing greenhouse, nursery, and field investigations on 40 accessions of 15 forage shrub species are reported. Some plantings were started in the greenhouse, hardened in the nursery, and transplanted on to the range study sites. Others were seeded directly on to the site. Accessions transplanted varied in germination speed, initial vigor, field growth, grazing proneness, and frost tolerance. Direct seedings showed marked differences in emergence both among accessions and study sites.

INTRODUCTION

Forage shrubs offer advantages in growth characteristics, nutritional qualities, and dependability under adverse conditions,<sup>2 3</sup> which are important for semiarid rangeland improvement. Therefore, a forage shrub adaptation study was initiated in the northern Arizona pinyon-juniper woodland during 1974.

All species tested are in the goosefoot family (Chenopodiaceae). This family contains many desirable forage species but also contains some species and accessions that accumulate dangerous levels of oxalates.<sup>4</sup> Hence, care must be exercised in recommending these species for rangeland plantings.

SITE DESCRIPTIONS

The study is being conducted at three locations, Red Mountain, Indian Flats, and Blue Grade, all within 40 miles of Flagstaff. Red Mountain, at 6,400 feet elevation, has an estimated annual precipitation of 12 to 14 inches with the largest part falling in the summer. Spring and fall are very dry and winters are cold. Indian Flats, at an elevation of 7,300 feet, has an estimated annual precipitation of 16 to 18 inches, a greater part of which falls in the summer but with adequate amounts in later winter to early spring to support cool-

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<sup>2</sup>Cook, C. W. Comparative nutritive values of forbs, grasses, and shrubs. Pp. 303-310. In *Wildland Shrubs--Their Biology and Utilization*. U.S. Dept. Agr., Forest Serv. Gen. Tech. Rpt. INT-1, 494 pp., illus. 1972.

<sup>3</sup>Dietz, D. R. Nutritive value of shrubs. Pp. 289-302. In *Wildland Shrubs--Their Biology and Utilization*. U.S. Dept. Agr., Forest Serv. Gen. Tech. Rpt. INT-1, 494 pp., illus. 1972.

<sup>4</sup>Keller, W., and Bleak, A. T. *Kochia prostrata*: a shrub for Western ranges? *Utah Sci.* 35(1): 24-25. 1974.

season species. This site is also dry during spring and fall and has cold winters. Blue Grade, at 5,000 feet elevation, has an estimated 18 plus inches of annual precipitation, more of which falls in the winter than summer but with adequate summer moisture to support warm season species. Spring and fall are dry; winter is milder than at the other two sites.

The dominant vegetation at both Red Mountain and Indian Flats is one-seed juniper (*Juniperus monosperma* (Engelm.) Sarg.) and pinyon (*Pinus edulis* Engelm.) with an understory of blue grama (*Bouteloua gracilis* (H.B.K.) Lag.). Soils are volcanic clay loams in the Thunderbird series. At Blue Grade the dominant vegetation is Utah juniper (*Juniperus osteosperma* (Torr.) Little) with an understory of shrub live oak (*Quercus turbinella* Greene). The soil is a volcanic, cobbly clay in the Springerville series.

## METHODS

Forty accessions of 15 shrub species were studied. Two planting methods were used--transplanting established plants and direct field seeding.

Transplants were started by the styrobloc method,<sup>5</sup> hardened in the nursery, then transplanted into cultivated strips at range locations when 11 weeks old. Thirty-four accessions were planted at Red Mountain on July 22, 25 accessions at Indian Flats on July 23, and 14 accessions at Blue Grade on July 25, 1974.

Plugs were watered at time of transplanting, then twice a week for 2 weeks, and once a week for 5 more weeks. One to two quarts of water per plant was applied.

All accessions were rated in the greenhouse for germination speed and initial vigor. Field transplants were observed and measured for growth, insect and rodent damage, and survival.

One accession of *Atriplex canescens* and two of *Kochia prostrata* were direct seeded at the three study sites. Furrows spaced 1-foot apart were formed in cultivated plots, and the seed was hand planted one-quarter inch deep. Observations and measurements were made on emergence, initial establishment, and growth.

Precipitation was measured weekly from July 18 to October 2 with a standard rain gage modified to minimize evaporation and eliminate freezing damage.<sup>6</sup> Total rainfall was 3.04 inches at Red Mountain, 3.36 inches at Indian Flats, and 2.71 inches at Blue Grade. Distribution was uneven with lengthy dry periods at each location.

## RESULTS AND DISCUSSION

### Transplants

In the greenhouse, 34 of the 40 accessions planted germinated and became established (table 1). Differences among accessions may have been inherent, or variations in seed viability, or an interaction of both.

Transplant survival was 33 of the 34 accessions planted at Red Mountain, 19

<sup>5</sup>Matthews, R. G. Container seedling production - a provisional manual. Dept. of the Environment, Pacific Forest Res. Centre, Canad. Forestry Serv. Inform. Rpt. BC-X-58, 48 pp., illus. 1971.

<sup>6</sup>Gomm, F. B. A modification of the standard Weather Bureau rain gage for summer and winter use. Amer. Met. Soc. Bul. 42: 311-313. 1961.

Table 1.--Observations and measurements for forage shrubs species and accessions transplanted on three pinyon-juniper sites in Arizona

Species and accession	Germination <sup>1</sup>	Red Mountain			Indian Flats			Blue Grade		
		Survival	Growth <sup>2</sup>	Damage <sup>3</sup>	Survival	Growth	Damage	Survival	Growth	Damage
		Percent	Mm		Percent	Mm		Percent	Mm	
<i>Atriplex canescens</i>										
PI 330657 <sup>4</sup>	P	100	14	M	( <sup>5</sup> )	---	---	---	---	---
PI 346419	P	100	40	L	---	---	---	---	---	---
A 17279 <sup>6</sup>	P	100	141	L	80	116	M	---	---	---
<i>A. lentiformis</i>										
SFB-40 <sup>7</sup>	G	100	57	M	0	0	M	0	0	M
<i>A. leptocarpa</i>										
PI 342565	P	29	10	H	---	---	---	---	---	---
<i>A. muelleri</i>										
PI 224963	P	50	28	H	---	---	---	---	---	---
<i>A. nuttallii</i>										
var. <i>falcata</i>										
SFB-26	P	40	39	H	0	0	L	---	---	---
<i>A. polycarpa</i>										
SFB-39	G - E	100	99	L	0	0	M	20	36	M
SFB-38	G - E	100	89	M	20	46	H	20	36	M
<i>A. pseudocampanulata</i>										
PI 342567	P	0	0	M	---	---	---	---	---	---
PI 330666	P	60	57	H	10	3	L	0	0	L
<i>A. rosea</i>										
PI 330667	G	80	137	M	30	14	H	20	20	L
<i>A. semibaccata</i>										
PI 270313	F	80	144	H	60	51	L	0	0	L
PI 299488	E	100	234	L	80	205	H	40	31	M
PI 299489	F	100	181	M	100	124	H	40	53	H
PI 316164	E	100	55	H	0	0	H	20	9	H
PI 342571	F	80	55	H	---	---	---	---	---	---
PI 342572	G	100	64	H	0	0	H	20	14	M
<i>A. suberecta</i>										
PI 368854	F	100	112	M	60	27	H	20	20	L

Table 1.--Observations and measurements for forage shrubs species and accessions transplanted on three pinyon-juniper sites in Arizona--Continued

Species and accession	Germination <sup>1</sup>	Red Mountain			Indian Flats			Blue Grade		
		Survival	Growth <sup>2</sup>	Damage <sup>3</sup>	Survival	Growth	Damage	Survival	Growth	Damage
		Percent	Mm		Percent	Mm		Percent	Mm	
<i>Eurotia ceratoides</i>										
PI 345730	E	100	57	L	90	76	L	60	51	M
<i>E. lanata</i>										
PI 348917	E	100	51	L	70	62	L	---	---	---
<i>Kochia prostrata</i>										
PI 330708	P	50	38	L	---	---	---	---	---	---
PI 356817	F - G	100	64	L	0	0	L	---	---	---
PI 356818	F	100	73	L	---	---	---	---	---	---
PI 356819	G	100	48	L	50	44	L	---	---	---
PI 356820	G - E	80	37	L	90	90	M	---	---	---
PI 356821	F - G	100	52	L	---	---	---	---	---	---
PI 356822	F - G	100	41	L	50	77	L	---	---	---
PI 356823	F - G	90	46	M	20	47	M	---	---	---
PI 356824	F	100	61	M	60	66	L	---	---	---
PI 356825	F - G	100	46	M	80	70	L	---	---	---
PI 356826	G	80	97	M	80	77	L	---	---	---
PI 314929	E	100	119	L	100	187	M	50	47	M
PI 358941	E	100	135	L	100	205	M	70	42	H

<sup>1</sup>Speed and vigor: E = Excellent, G = Good, F = Fair, P = Poor.

<sup>2</sup>Maximum stem length.

<sup>3</sup>Grazing damage by insects and small mammals: L = Low, M = Medium, H = High.

<sup>4</sup>ARS, Pullman Regional Plant Introduction Station identification number.

<sup>5</sup>Not transplanted.

<sup>6</sup>SCS, Tucson Plant Materials Center identification number.

<sup>7</sup>Pacific Southwest Forest and Range Experiment Station identification number.

of the 25 planted at Indian Flats, and 11 of the 14 planted at Blue Grade (table 1). Percentage survival of individual plants within each accession was highest for Red Mountain, intermediate for Indian Flats, and lowest for Blue Grade (table 1).

Maximum stem lengths varied among accessions and sites (table 1). *Atriplex semibaccata*, P.I. 299488, had the longest stems at both Red Mountain and Indian Flats, but *A. semibaccata*, P.I. 299489, was longest at Blue Grade. Relative growth and vigor varied among accessions throughout the observation period, some stayed the same, others improved, and still others declined.

Frost damage occurred only at Red Mountain. This damage was observed October 1 on all of the *Atriplex semibaccata* accessions and on *A. rosea*, P.I. 330667, and *A. suberecta*, P.I. 368854. Damage was expected because most of the affected accessions were described as cold sensitive.<sup>7</sup>

Accessions differed in palatability as evidenced by small mammal and insect grazing damage. Table 1 shows these differences expressed as relative ratings. Variation among study sites could have resulted from differences in associated vegetation and in kinds and numbers of predators.

#### Direct Seedings

Emergence of *Kochia prostrata*, P.I. 358941, was markedly superior to *K. prostrata*, P.I. 314929, for direct seedings at Red Mountain and Indian Flats (table 2). Germination and initial establishment had been excellent for both accessions in the greenhouse (table 1). No seedlings emerged at Blue Grade.

Table 2.--Density and growth of direct seeded forage shrubs

Species, accessions, and measurements	Red Mountain	Indian Flats	Blue Grade <sup>1</sup>
<i>Atriplex canescens</i> , A 17279: <sup>2</sup>			
Seedlings per linear foot	14.7	14.9	0
Maximum stem length in millimeters	39	24	0
<i>Kochia prostrata</i> , P.I. 314929: <sup>3</sup>			
Seedlings per linear foot	3.1	0.2	0
Maximum stem length in millimeters	28	40	0
<i>Kochia prostrata</i> , P.I. 358941:			
Seedlings per linear foot	31.5	9.5	0
Maximum stem length in millimeters	37	38	0

<sup>1</sup>No seedlings emerged.

<sup>2</sup>SCS, Tucson Plant Materials Center identification number.

<sup>3</sup>ARS, Pullman Regional Plant Introduction Station identification number.

A comparison of maximum stem length indicates that transplants averaged 3.8 times as large as direct seedings at Red Mountain and 5 times larger at Indian Flats (tables 1 and 2). The transplants were 11 weeks older than the seedlings and received supplemental irrigation. Transplanting, even though more costly than direct seeding, might prove feasible for areas where vegetative cover is essential to protect high value improvements.

<sup>7</sup>A. M. Davis, written commun., January 1974.

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