Productivity of Tall Wheatgrass and Great Basin Wildrye under Irrigation on a Greasewood-Rabbitbrush Range Site

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Highlight: *Nonbeneficial phreatophytes, greasewood and rubber rabbitbrush, in the Humboldt River Basin annually waste approximately 103,000 acre feet of water that could be used beneficially if forage species were established. After brushbeating, tall wheatgrass and Great Basin wildrye were spring seeded and established by sprinkler irrigation. Irrigation was continued for 3 to 5 years to induce root penetration into a capillary fringe so that grasses would persist as beneficial phreatophytes. After irrigation ceased, productivity of 115 to 710 lb/acre indicated that roots had not reached the capillary fringe and that continued irrigation was necessary to maintain production. Soil physical characteristics restricted root growth, and productivity with limited water or without water was reduced by chemical properties of a saline-sodic soil. Highest production of tall wheatgrass (4000 to 6000 lb/acre) and Great Basin wildrye (2400 to 2600 lb/acre) was obtained 3 years after seeding with weekly irrigations of 1.25 inches.*

About 394,000 acres of greasewood (*Sarcobatus vermiculatus*) and rubber rabbitbrush (*Chrysothamnus nauseosus*) grow in the Humboldt River Basin of northern Nevada. (Nev. Dep. Conser. and Natur. Resources and U. S. Dep. Agr., 1966). These nonbeneficial phreatophytes waste approximately 103,000 acre ft of water yearly. A large portion of this water could be put to beneficial use if phreatophytic vegetation were replaced by plants of higher economic value (Rollins et al., 1968). Dylla and Muckel (1967) speculated that forage species could be established and rooted in the capillary fringe by supplemental irrigation, then grown as phreatophytes without further irrigation. Jensen et al. (1965) reported that one-half to two-thirds as much beef can be produced with well-managed tall wheatgrass on saline-sodic soils as on more desirable land. The objective of this study was to evaluate the longevity and productivity of established stands of seeded species under different irrigation systems.

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Procedures

The study site was in Paradise Valley about 25 miles from Winnemucca in northcentral Nevada. Mean annual precipitation is 8.9 inches. For 7 years water-table depth varied between 5.9 and 9.2 ft and usually dropped about 1.3 ft during the growing season. The capillary fringe wet to about 2.5 ft in the spring. Microrelief was coppice dunes under vegetation surrounded by flat areas of compact barren soils. Coppice sites averaged 33% of the surface. A description of soil chemical and physical properties was presented by Rollins et al. (1968) and Stuart et al. (1971). Cover of native species was 7.1% greasewood, 4.6% rabbitbrush, and 2.7% big sagebrush (*Artemisia tridentata*). Great Basin wildrye (*Elymus cinereus*) and saltgrass (*Distichlis stricta*) occurred in small amounts.

The only method of site preparation was brushbeating. Alkar tall wheatgrass (*Agropyron elongatum*) and Great Basin wildrye were seeded in 12-inch rows at the rate of 2 pls/inch of row in May. Seed was drilled in the surface soil in 1962 and either drilled in the surface soil or in 6-inch deep furrows in 1963 and 1964.

Previous work showed that seedlings could not be established without irrigation. In 1962 and 1963, seedlings were established by one or two sprinkler-applied irrigations/week of approximately 1.25 inches. The following year half the plots received one irrigation/week, while the remainder were not irrigated. Two irrigation treatments were used on the 1964 seeding (Table 1). Water was obtained from shallow ground-water wells (Dylla and Muckel, 1967). Since seedlings established only on dune soil (Rollins et al., 1970), production data were corrected for percent of plot with grass. Three or four replications were used. Production data were analyzed by analysis of variance for a split-plot design, with irrigation treatments the main plots and seedbed and species treatments the subplots. A probability level of 5% was accepted as significant unless otherwise indicated.

Results

Rollins et al. (1968), presented results of the 1962 seeding and reasons for success or failure to establish replacement species on dune and playa soils. The 1963 and 1964 seedings gave similar results, although plant density was lower on the latter. Significantly more seedlings were established with two irrigation/week (19.5 and 11.2 plants/ft of row (pfr) in 1963 and 1964, respectively) than with one/week (15.6 and 8.6 pfr). Density of

Table 1. Irrigation schedule for seedling establishment (1964) and production (1965-1971) of tall wheatgrass and Great Basin wildrye for a 22-week period each year.

	Schedule A				Schedule B			
Year	Frequency	Inches per irrigation	No. of irrigations	Feet applied	Frequency	Inches per irrigation	No. of irrigations	Feet applied
1964	2/week	0.75	44	2.8	Weekly	1.25	22	2.3
1965	Weekly	1.25	22	2.3	Biweekly	2.50	11	2.3
1966	Weekly	1.25	22	2.3	Biweekly	2.50	11	2.3
1967	Weekly	1.50	22	2.8	Biweekly	3.00	11	2.8
1968	Biweekly	3.00	11	2.8	Monthly	3.60	6	1.8
1969	None	0.00	0	0.0	None	0.00	0	0.0
1970	None	0.00	0	0.0	None	0.00	0	0.0
1971	None	0.00	0	0.0	None	0.00	0	0.0
Total				13.0				11.5

wheatgrass was higher (17.6 and 9.9 pfr) than for wildrye (11.7 and 7.4 pfr). Seedbed treatments were significantly different only in 1964 when density in furrows (10.1 pfr) was greater than in the drill treatment (7.2 pfr). These results showed that even the poorer irrigation, seedbed, and species treatments produced excellent seedling stands on dune soils. Stands were not established on playa soil.

Yield response on the 1962 and 1963 seedings was evaluated for 3 years. On both seedings, one irrigation/week produced more herbage (1002 lb/acre) than did no irrigation (179 lb/acre). Wheatgrass and wildrye produced similarly in all years after the 1962 seeding. On the 1963 seeding, wheatgrass (821 lb/acre) produced significantly more than did wildrye (268 lb/acre). Maximum production of both species declined rapidly without irrigation. For example, yield the first year without irrigation ranged from 56 to 96% of that with one irrigation/week. Yield the second year ranged from 14 to 24%, and in the third year from 0 to 3% of that with irrigation.

Such a rapid decline in yield and low yield indicated that established grasses were not partial phreatophytes and that some irrigation was necessary to maintain productivity and perhaps to stimulate root growth into the capillary fringe. Production data (Table 2) for extended irrigation treatments on the 1964 seeding are discussed by year-periods: 1965-1967; 1968; and 1969-71.

1965-67

Although excellent stands were obtained with both irrigation treatments in 1964, yearly production in 1965, 1966, and 1967 was significantly greater with weekly irrigation. Wheatgrass produced more than did wildrye in each year. Yield did not vary with seedbed treatment except in 1967 when more herbage was produced in furrows. Highest production was from wheatgrass in furrows in 1967. Production was least in 1965, higher in 1966, and greatest in 1967.

1968

Less frequent irrigation in 1968 resulted in significantly less yield than in any previous year. Production was greater with two irrigations/month than with monthly irrigation. Wheatgrass produced more than did wildrye. A significant (0.10) irrigation x seedbed interaction indicated that with less water, production was maintained at a higher level in the furrows than in the drill treatment. In fact, production in furrows was greater than in any year except 1967.

1969-1971

A year after all irrigation had ceased, total production was significantly less than in the preceding year. Wheatgrass produced more than wildrye in 1969, but the two species were similar in 1970 and 1971. Production was greater in furrows in 1969, but did not vary with seedbed treatment in 1970 and 1971. For 1 year after irrigation ceased, higher productivity was maintained in furrows than in the drill treatment. In 1971, no treatment or interaction significantly affected yield. By 1970 and 1971 productivity had reached equilibrium with the existing site factors and yield was significantly lower than in any other year. Although grass production varied between 134 and 710 lb/acre in 1970 and between 115 and 595 lb/acre in 1971, plant vigor was poor. Many dead portions of bunches were evident and reproductive culms were absent on plants in solid rows. Average leaf length of wheatgrass and wildrye was 10 and 12 inches, respectively. These plants did not appear capable of withstanding grazing pressure.

Results indicate that even after supplemental irrigation for 5 years, roots had not reached the capillary fringe. This conclusion is supported by comparative yield of tall wheatgrass (2940 lb/acre) grown in lysimeters with a water table in the root zone (Dylla et al., 1972).

Discussion and Conclusion

Irrigation was required to establish potentially productive stands of tall wheatgrass and Great Basin wildrye. Excellent production was obtained after 2 to 3 years with weekly irrigations of approximately 1.25 inches of water. With irrigation, wheatgrass was more productive than wildrye. High production was not maintained without irrigation although production with limited water was greater in furrows. Use of furrows was not necessary for establishment, and a furrow effect could not be maintained under grazing or haying without periodic land treatment. Varying degrees of productivity were maintained for 1 year after cessation or irrigation, perhaps because some water from the previous year's irrigation was stored in the soil profile.

Robertson (1955), found roots of tall wheatgrass to depths of 11 ft in irrigated saline-alkali soils. Therefore, in the present study, why was a productive stand not obtained without irrigation when the capillary fringe was at 2.5 ft at the beginning of the growing season and dropped to only 3.8 ft during the growing season? Soil morphology and chemistry provide the best answers. Stuart et al.

Table 2. Production (lb/acre) of two species for 7 years in response to irrigation and seedbed treatments. Seeding was made in May, 1964.

Irrigation schedule	Species	Seedbed	Production 1965	1966	1967	1968	1969	1970	1971
A	Tall wheatgrass	Drill	1138	2669	4224	2726	1517	461	595
		Furrow	1050	3091	6163	2534	1382	134	480
	Basin wildrye	Drill	654	2227	2611	1939	442	710	365
		Furrow	530	1613	2419	1632	864	384	346
B	Tall wheatgrass	Drill	694	1651	1651	1709	614	230	346
		Furrow	727	2208	5434	3994	2189	403	499
	Basin wildrye	Drill	115	192	499	134	154	154	115
		Furrow	134	576	1081	1344	806	691	441

(1971), found horizons very strongly cemented by calcium or silica at depths of 1.6 to 2.8 ft. Grass roots were abundant above these horizons. Only a few roots were found in the strongly cemented plates with only an occasional root below. Obviously, this horizon limited root penetration to the capillary fringe, and water in the fringe was unavailable to seeded grasses for most of the growing season. Without irrigation, this site had the productive capacity of a dryland environment. This dryland environment perhaps was aggravated by the saline-sodic soil. Soil chemistry of dune soils to the 3.5 ft depth showed: pH range of 8 to 10; conductivity range of 5 to 20 mmhos/cm; exchangeable sodium range of 27 to 75%; and boron range of 5 to 18 ppm. Under these conditions of restricted rooting depth and saline-sodic soils, soil moisture tension, osmotic pressure of the soil solution, and possible specific-ion effect from sodium and boron may be responsible for reduced yield without irrigation.

Significant yield differences from irrigation treatments in 1965, 1966, and 1967 were obtained with approximately the same amount of water (Table 1). Jensen et al. (1965) reported that stand establishment in saline-sodic soils was enhanced by more frequent irrigation because more moisture remained in the surface soil prior to the next irrigation. This same relationship may be important in stand productivity since more water in the root zone would lower moisture tension, dilute and leach salts[1], and reduce pH and sodium.

The amount of water that can be applied to maintain production depends on groundwater availability and pumping costs. Dylla and Muckel (1967) estimated that the cost of water pumped by gasoline engine at a rate of 30 gpm for a 1920 hr/season from a shallow aquifer (21 ft) was $18.61/acre ft. Water cost for the one irrigation/week treatment would be $42.80 for 1965 and 1966, and $52.11 for 1967. The highest water-use efficiency was obtained in 1967 with one irrigation/week and was 153 and 95 lb hay/acre inch of water, respectively, for tall wheatgrass and Great Basin wildrye.

Areas selected for treatment should have a large portion of the microrelief with soil of chemical and physical characteristics suitable for this kind of revegetation program. In practice, brush could be killed with herbicides and the area seeded the following spring with a rangeland drill.

[1] Unpublished data, Darrell M. Stuart, Agricultural Research Service, Soil and Water Conservation Research Branch, U.S. Dep. Agr., University of Nevada, Reno.

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