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Weeping Lovegrass as a Potential Bioenergy Crop

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ABSTRACT

Weeping lovegrass (*Eragrostis curvula* Schrad. Nees.) is an introduced, perennial bunchgrass forming large clumps with abundant drooping basal leaves. It is widely adapted to much of the southern and southeastern U.S. Weeping lovegrass is often used for erosion control on sites with severe conditions because it has been reported to tolerate drought, frost, high pH, heat, low pH, mine spoils, poor soils and slope. Weeping lovegrass is relatively easy to establish from seed and mature stands can produce dry matter yields of 5 tons/acre with adequate fertilization. Further research is needed to determine the optimum clipping frequency, fertilization rate and energy conversion efficiency before weeping lovegrass could be recommended for use as a biofuel crop.

INTRODUCTION

The genus *Eragrostis* has over 250 identified species in tropical and temperate regions around the world (Gould and Shaw, 1983). Three introduced species, weeping lovegrass (*Eragrostis curvula* Schrad. Nees), Boer lovegrass (*E. chloromelas* Steud.), and Lehmann lovegrass (*E. lehmanniana* Nees) have the greatest potential for agricultural use in the United States. Of the three species, weeping lovegrass is more drought tolerant and has greater forage and seed production than Lehmann or Boer lovegrass (Alderson and Sharp, 1994).

Weeping lovegrass is a long-lived, tufted perennial bunchgrass forming large clumps with abundant drooping basal leaves. The drooping leaf characteristics gives rise to the name "weeping" lovegrass. With adequate moisture plants reach a height of 24 to 60 inches (Alderson and Sharp, 1994). The basal leaves are long (24 to 48 inches), slender, tapering to fine hair like browning threads. The species is apomictic, although sexual plants have occasionally been found (Crider, 1945 and Voigt, 1996). Weeping lovegrass was introduced into the United States from North central Tanganyika (Tanzania), Africa in 1927 (Alderson and Sharp, 1994). In Africa, weeping lovegrass is a subclimax species found on disturbed sites maintained by heavy grazing, burning, or land clearing (Crider, 1945). In the late 1930's weeping lovegrass was increased and tested as an erosion control plant at the Nursery Division of the Soil Conservation Service in Tucson, Arizona.

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Adaptation

Weeping lovegrass is well adapted to a wide range of soils from coarse sand to heavy silts and clays. Weeping lovegrass will grow on a wide range of soil pH. It has performed well in acid mine spoils with a pH as low as 4 and on alkaline soils in southern New Mexico and Arizona with a pH of 8 (Crider, 1945). Dalrymple (1976) found that a high alkaline soil where sodium uptake exceeds 1% has resulted in plant death. Weeping lovegrass requires between 15 to 20 inches of rainfall per year to become permanently established and produce adequate dry matter yield (Crider, 1945). The grass is drought resistant but it does perform well in areas with higher rainfall and well-drained soils.

Weeping lovegrass is cold tolerant to plant hardiness Zone 7a. Zone 7a has an average minimum temperature of 0 to 5 F°. Crider (1945) reported that first-year plantings of weeping lovegrass survived uninjured in Beltsville, MD at low temperatures of minus 16 F° and well-established plantings withstood temperatures as low as minus 20 F° in Deansboro, NY. However, severe winters in Manhattan, KS, Woodward, OK, and Cheyenne Wells, CO killed seedlings of weeping lovegrass. Temperature alone is not the most important factor in winter survival. A combination of factors such as soil type, soil moisture, humidity, and snow cover is also involved (Denaman et. al., 1953). From these reports, a minimum temperature for weeping lovegrass has been set at minus 10 F°.

Weeping lovegrass is adapted to much of the southern and southeastern United States. The northern range of adaptability extends from southern New England across southern Kentucky and Missouri, to northern Oklahoma and Texas across southern New Mexico and Arizona (Crider, 1945 and Dalrymple, 1976).

Conservation Uses

Weeping lovegrass was first introduced and widely used for erosion control in the southwest and south central United States during 1936-1945 (Holt and Dalrymple, 1979). It is an excellent grass to use on critical areas such as roadways, eroded areas, and other drastically disturbed sites. Crider (1945) identified the following characteristics as to why weeping lovegrass is such a useful plant for conservation.

1. Adaptability to many and varied soils, particularly the poorer classes.
2. Easy and quick establishment under adverse conditions.
3. Rapidity of growth and maturity during critical periods.
4. Production of thick masses of vegetative soil cover.
5. Voluminous, tenacious, and deeply penetrating root system.
6. Resistance to destructive agencies such as blowing sands, floods, fire, weed competition, and decay.
7. Ready self-seeding habits.
8. Heavy yields of viable seeds.
9. Adaptation to simple methods of culture.
10. Ease of eradication when circumstances warrant.

Establishment

Weeping lovegrass is relatively easy to establish from seed (Staten and Elwell 1944, Crider, 1945, Dalrymple, 1976, Bovey, 1983 and Voight, 1983). Seedbed preparation is a major factor in controlling weed competition because stands can fail where severe weed infestations exist (Bovey and Voight, 1984 and Matizha and Dahl, 1991). Because of the wide distribution of weeping lovegrass, seedbed preparation techniques should maximize local moisture and soil conditions.

Seedbed preparation should begin weeks before seeding to allow the soil to settle. Successive disking and harrowing has proven to be effective means to prepare the seedbed (Staten and Elwell 1944, Dalrymple, 1976). The seedbed must not only be clean but also firm throughout the soil profile and friable on the surface to insure shallow uniform seed placement (Dalrymple, 1976). A cultipacker or heavy roller should be used to firm seedbed before and after planting if soil is loose or unsettled.

Weeping lovegrass can be drilled, broadcast or established by sod. Seeding rates of weeping lovegrass should be based on soil type and method of establishment. Use 30 to 50% more seed on clay soils. In sandy loam 1 to 2 pure live seed pounds per acres can be planted with a drill. Broadcast planting requires doubling the seeding rate of drill planted seed. One pound of weeping lovegrass seed per acre uniformly spread equals 35 to 40 seed per square foot (Dalrymple, 1976). Weeping lovegrass planted on critical areas with rough seedbeds, eroded soil or high water movement should double or triple normal seeding rate (Dalrymple, 1976). If established by sod, place pieces every 12 to 20 inches apart in the row (Staten and Elwell, 1944 and Crider, 1945).

Shallow seed placement is essential with seeds being placed no deeper than ¼ to ¾ inch in the seedbed (Staten and Elwell, 1944, Dalrymple, 1976, Crider, 1945). Planting dates vary because of the wide range of adaptability but a good rule of thumb is to plant before the last frost of the spring (Dalrymple, 1976). Successful stands have been established between April 1 to June 15 across many locations and soil types (Staten and Elwell 1944, Crider, 1945, and Dalrymple, 1976).

Germination of viable seed can exceed 90% in 4 to 5 days. However, germination and emergence usually take 1 to 2 weeks under favorable field conditions (Dalrymple, 1976). Webster et al., (1986) found that if moisture was not sufficient to stimulate emergence, seeds remained viable and emerged later when adequate moisture was available. In 3 to 4 weeks, primary roots complete their function of seedling establishment and begin to tiller. One clump may contain hundreds of culms, each originating from beneath the soil in the crown of the plant (Dalrymple, 1976).

Stand Management

Careful management during the first season is crucial for adequate root development, winter survival, and vigorous growth the following spring (Rommann and McMurphy, 1983). Do not graze or remove top growth during the first year until weeping lovegrass reaches 12 to 15 inches in height and has produced a uniform stand (Dalrymple, 1976 and Rommann and McMurphy, 1983).

To maximize grazing potential of weeping lovegrass the previous years growth must be removed before active growth begins in the spring by grazing, mowing or burning (Klett et al., 1971, Rommann and McMurphy, 1983 and Dahl, 1984). Klett et al., (1971) found that plants containing previous years growth contain 75-80% dead vegetation in the crown area. New tillers only formed on the outer ring of the crown. Roberts et al. (1988) found that high intensity fires did not damage weeping lovegrass. Competition can be removed with fire with no adverse effects. Klett (1984) found that burning increased yields of weeping lovegrass 14% and utilization 53%.

Biomass Production

Weeping lovegrass usefulness as a forage crop is dependent on adequate fertilization and stage of maturity at harvest. Weeping lovegrass forage quality declines rapidly as the grass matures. Cotter et al., (1983) outlined the following weeping lovegrass management principles to maximize quality.

1. Keep the leaves of weeping lovegrass young and high in quality.
2. Stock heavy enough to graze off the high quality forage in a few days.

3. Prevent spot grazing.
4. Use weeping lovegrass with alternative types of forage.
5. Fertilize.
6. Defer grazing weeping lovegrass during the fall.
7. Fall regrowth should be grazed off or otherwise removed following dormancy.
8. Do not graze weeping lovegrass during spring greenup (until it reaches 6 inches).

McMurphy et al. (1975) found that weeping lovegrass compared favorably to switchgrass across all N rates (Table 1). The maximum yield of each species was 8,418, 8,296, 5,662 and 7515 lbs/acre for switchgrass, weeping lovegrass, indiangrass, and big bluestem, respectively. Weeping lovegrass and switchgrass were the two most productive species at 180 lbs of N and 40 lbs of P. Klemp (1981) reported weeping lovegrass 3 year average yields as high as 11,876 lb/acre (Table 2).

Table 1. Forage production of weeping lovegrass, 4 year average 1966 – 1969.

Fertilizer		Production			
N	P	Big Bluestem	Indiangrass	Switchgrass	Weeping Lovegrass
		----------kg / ha ----------			
0	0	3081	1448	2295	1834
0	40	3148	1259	2124	1815
45	0	5303	3562	5211	4385
45	40	5670	3491	5633	4613
90	0	5961	4600	6455	5975
90	40	7515	5213	7166	6715
180	0	5153	5079	6372	7267
180	40	6233	5662	8418	8296

This table appears in McMurphy et al., 1975

Potential Negative Effects

There is a movement within the plant science community to emphasize the use of native plants and to move away from using introduced species such as weeping lovegrass. With this trend, it is necessary to focus on a plants mode of reproduction and its potential to escape the intended area of use. The Virginia Natural Heritage Program has identified weeping lovegrass as an invasive alien plant species because of its drought tolerance and ease with which seed based propagation occurs (VNHP Fact Sheet, 1997). These characteristics are normally "desirable" but in certain situations weeping lovegrass has escaped the intended area of use. It should also be noted that Brown and Phillips (1989) found that weeping lovegrass could serve as over wintering habitat for boll weevils (*Anthonomus grandis grandis* Boheman). When compared with existing shinnery oak leaf litter, weeping lovegrass planted along contour terraces on the High Plains of Texas provided suitable over winter habitat for boll weevils.

Table 2. Yields of 4 weeping lovegrass varieties at three fertility levels. Red River Demonstration and Research Farm, Noble Foundation, Ardmore, Okla., 1975.

Variety	Fertility	May 18	June 18	Aug 20	Nov 18	Total	3 y Tot	Avg.
		---------- ------lb / acre ----------						
Comm	Low	3352	1897	1011	705	6965	20848	6949
	Med.	3497	2751	1311	2333	9892	26105	8702
	High	3693	3813	2872	1225	11603	31854	10618
	Avg.	3514	2820	1731	1421	9486	26268	8756
Ermelo	Low	3104	1977	1219	649	6949	20238	6746
	Med.	3214	2487	1382	2576	9659	25273	8624
	High	3127	4065	2946	1254	11392	32941	10980
	Avg.	3148	2843	1849	1493	9333	26150	8717
Morpa	Low	2783	1934	990	664	6371	19546	6515
	Med.	3025	2056	1389	2489	8959	24355	8118
	High	3213	3354	2400	1287	10254	28128	9376
	Avg.	3007	2448	1593	1480	8528	24009	8003
Renner	Low	2653	1835	930	505	5903	18474	6158
	Med.	3275	2285	1102	2841	9503	26092	8697
	High	3062	3851	2810	1260	10983	35628	11876
	Avg.	2997	2657	1614	1635	8803	26730	8910

3 year average fertilization levels (lbs/acre, N-P-K)
Low = 70-20-20 Med. = 140-20-20 High = 320-20-20

This table appears in Klemp, 1981.

Langston and McMurphy (1972) reported that 200 lbs of N and 40 lbs of P produced the highest weeping lovegrass yields. The four year average yield was 7,591 lbs per acre (Table 3).

Table 3. Weeping Lovegrass Production (lbs/acre), Kirkland Silt Loam Soil, Stillwater.

Fertilizer		**Year**			
N	**P**	**Switchgrass / Indiangrass**	**Weeping Lovegrass**	**Plains Bluestem**	**Bluestem Blend**
		---------- lb/acre ----------			
0	0	2781	2839	2618	2871
0	40	2812	3077	2410	2672
50	0	4328	4734	3911	3859
50	40	4297	5032	4457	4684
100	0	5350	5366	4470	4357
100	40	4993	6248	5394	6427
150	0	3641	5012	4168	4763
150	40	5804	7084	6171	7135
200	0	5142	5763	4589	4996
200	40	5992	7591	6561	6802

This table appears in Langston and McMurphy, 1972

Varieties

Common or 'A-67' weeping lovegrass is from the original collection made by the USDA-Natural Resources Conservation Service (formally the Soil Conservation Service), Plant Materials Center in Tucson, Arizona. The A-67 weeping lovegrass studied by Crider (1945) was never officially released and is sold as common weeping lovegrass (Voigt et. al., 1996).

'Ermelo' was released by the Texas A&M University Research and Extension Center (formally the Texas Research Foundation) in Dallas, Texas. It was collected from native stands in the Ermelo district of South Africa in 1944 (Alderson and Sharp, 1994). Ermelo is more palatable than Common (Klemp, 1981). It is the same type of plant, except it is slightly taller, often darker green and has slightly wider leaves. Ermelo is the most widely available commercial source of weeping lovegrass

'Morpa' was released by Oklahoma State University and USDA-ARS, in Woodard, Oklahoma. It was selected in Oklahoma from seed from Transvaal, South Africa. It is about 3 inches taller, with darker panicles, and the leaves are slightly wider than common lovegrass (Dorsett, 1973). It also contains less lignin and produces 12-13% higher live weight in stock. Morpa is also more palatable than common (Alderson and Sharp, 1994). The name is derived from the two words more palatable.

'Renner' weeping lovegrass (*Eragrostis robusta*) was released by Texas A&M University Research and Extension Center (formally the Texas Research Foundation) in Dallas, Texas. Renner is a much more robust, semi-erect, dark green to blue-green grass with a wider leaf than all other varieties (Klemp, 1981). This variety is more competitive due to a more dense, semi-prostrate crown. Renner is the least cold hardy of the varieties but it survives into central Oklahoma (Klemp, 1981). Robusta types can be highly productive (Dalrymple, 1976) and resistant to drought (Farrington et. al., 1973) and produce more vegetative growth of a higher quality in the fall than curvula types (Voigt, 1975, Dalrymple, 1976 and Klemp, 1981).

CONCLUSIONS

Weeping lovegrass has been planted extensively in the Southern U. S. as a conservation and forage grass (Holt and Dalrymple, 1979). Statements such as, "You can't starve cattle enough to get them to eat it", illustrates the love hate relationship that producers have had with weeping lovegrass (Dahl, 1984). The use of weeping lovegrass has ranged from total rejection to enthusiastic acceptance depending on the type of management practiced (Staten, 1944).

Numerous studies have focused on improving the forage quality of weeping lovegrass. The two greatest factors effecting forage quality are fertilization and maturity of plant at harvest. While these factors are important for forage quality, they do not necessarily translate to biofuel production.

If weeping lovegrass is to be used as a biofuel crop, the focus will need to be on total dry matter yield production not quality. Yields reported in this literature review indicated that weeping lovegrass has the potential biomass production to make it a viable alternative to switchgrass. The following questions need to be addressed before weeping lovegrass can be recommended for a bioenergy crop.

1. How will fewer harvests (i.e. 1, 2, or 3 cut systems) effect weeping lovegrass dry matter yield?
2. What is the optimum fertility requirement for maximum yield?
3. What is the fuel quality of weeping lovegrass?

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