823

USDA Forest Service
General Technical Report RM-191

May 1990

Effects of Fire Management of Southwestern Natural Resources

Proceedings of the Symposium

November 15-17, 1988
Tucson, AZ

J. S. Krammes, Technical Coordinator

[1]Headquarters is in Fort Collins, in cooperation with Colorado State University. Krammes is at the Station's Research Work Unit in Tempe, in cooperation with Arizona State University.

Seedbed Ecology of Lehmann Lovegrass in Relation to Fire[1]

L. B. Sumrall, B. A. Roundy, J. R. Cox and V. K. Winkel[2]

Abstract.—High seedling emergence of the exotic Lehmann lovegrass (*Eragrostis lehmanniana*) after burning is due mainly to removal of the overstory grass canopy. Canopy removal increases germinability and emergence by changing the light and temperature environment of the seedbed, not by increasing the period of soil water availability.

Lehmann lovegrass (*Eragrostis lehmanniana* Nees.), a drought tolerant, warm season perennial bunchgrass, was introduced to Arizona over 50 years ago (Cable 1971). It now covers over 200,000 ha in southeastern Arizona (Cox and Ruyle 1986). This grass provides important cover for erosion control and forage for livestock on many southwestern rangelands lacking native perennial grass cover. However, Lehmann lovegrass is not evenly utilized by grazing animals due to its stemmy habit (Ruyle et al. 1987) and its invasion into native grasslands may decrease biological diversity (Bock et al. 1986). Fire has been considered as a management tool to address both of these concerns.

Fire may reduce residual lovegrass biomass and improve forage utilization. Although it has been hoped by some land managers that fire might favor native grass establishment at the expense of Lehmann lovegrass, this does not appear to be the case. Lehmann lovegrass seedling emergence increases after burning, especially when mature plants are killed (Cox and Ruyle 1986). Increased seedling emergence is due, in part, to direct effects of the heat of the fire on the seed, possibly by increasing germination through seedcoat scarification (Ruyle et al. 1988). However, burning might also create a favorable environment for seedling emergence by removing the grass overstory canopy. This could result in more favorable light, soil water, and temperature conditions for Lehmann lovegrass seed germination and seedling establishment. An understanding of fire effects on the seedbed environment in relation to establishment requirements is necessary to determine how fire or other management practices may be used to either favor or disfavor persistence of Lehmann lovegrass. The purpose of this ongoing study is to determine the effects of fire on the seedbed environment that influence seedling emergence of Lehmann lovegrass.

Study Site and Methods

The study is being conducted on the Santa Rita Experimental Range 60 km south of Tucson, Arizona. The study site is at 1200 m elevation and supports a nearly pure stand of Lehmann lovegrass. Annual precipitation averages 398 mm with 60% falling between June and September. The soil is a Comoro fine sandy loam, Typic Torrifluvent.

Treatments were structured to compare effects of eliminating the canopy and eliminating competition for water by mature plants with the direct effect of burning on seedling emergence. The area was divided into 4 blocks, each containing 8 plots 7.5 by 15 m in area. Treatments were assigned to plots in a randomized complete block pattern (table 1). For the control treatment, mature plants and grass canopy were left intact. The burn treatment consisted of burning in November and spraying with glyphosate to kill surviving mature plants in April. This resulted in an initial seedbed heat treatment and elimination of the grass canopy. The clip treatment consisted of mowing mature plants to a 5-cm stubble height in November and spraying with glyphosate to kill mature plants

Table 1.—Treatments applied to a stand of Lehmann lovegrass at the Santa Rita Experimental Range.

Treatment	Expected effect on seedbed		
	Light	Water	Initial heat treatment
Control (control)	-	-	-
Burn Nov., spray (with glyphosate) (burn)	+	+	+
Clip and spray (clip)	+	+	-
Spray only (dead standing)	-	+	-

[1]Poster paper presented at the conference, Effects of Fire in Management of Southwestern Natural Resources (Tucson, AZ, November 14-17, 1988).

[2]Sumrall and Winkel are graduate research assistants and Roundy is assistant professor, School of Renewable Natural Resources, University of Arizona, Tucson, Arizona. Cox is range scientist, USDA/ARS, Tucson, Arizona.

in April. This resulted in an elimination of the grass canopy but without an initial heat treatment. The dead standing treatment consisted of spraying live mature plants in April to kill them and eliminate their use of soil water while leaving the dead canopy intact.

To determine pre-emergence germinability of seeds in the seedbank, 8 bioassay samples, 5 by 6 cm in area and 1-cm deep, were collected from each plot prior to summer rains in July. All samples were watered in the greenhouse and number of emergent seedlings recorded.

Seedling emergence was monitored regularly through the growing season starting after consistent summer rainfall occurred in July. Seedling density was quantified in 20 0.25–m^2, permanently-marked quadrats per plot. Soil temperatures, incident solar and net radiation, and soil water potential were measured with thermocouples or thermisters, pyranometers and net radiometers and gypsum blocks, respectively, and recorded using electronic microloggers. Measurements were recorded for selected periods in fall, winter, and spring, and were continuously recorded during the summer rainy season.

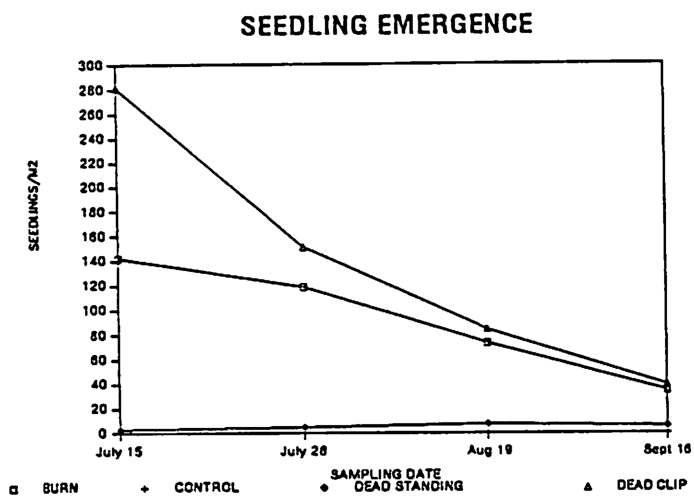

Figure 1.—Seedling densities of Lehmann lovegrass with overstory grass canopy intact and alive (control), intact but dead (dead standing) or removed by burning (burn) or clipping (dead clip).

Results and Discussion

Bioassay samples taken in July indicate that there were numerous germinable Lehmann lovegrass seeds in the seedbed prior to the summer rains. Bioassay samples produced 2,385; 1,198; 573 and 1,010 seedlings/m^2 on clipped, burned, control and dead standing canopy treatments, respectively. Plots where the grass canopy was removed by clipping had significantly ($P \leq 0.05$) more germinable seeds than other plots. Field plots where the canopy was removed, either by clipping or burning, had significantly ($P \leq 0.05$) greater seedling emergence than those with an intact canopy (fig. 1). The percentage of germinable seeds (as indicated by bioassay) which emerged (as indicated by maximum field seedling density on 14 July) was 11.8, 11.9, 0.02 and 0.26 for clipped, burned, control and dead standing canopy plots, respectively. Removing the canopy apparently not only increased germinability of seeds in the seedbank, but also increased the number of germinable seeds that emerged as seedlings.

Removal of the canopy may change the soil water, temperature and light conditions of the seedbed. Soil water potential was high on all plots during the period of maximum seedling emergence. During a subsequent drying period, water potentials decreased more rapidly on burned

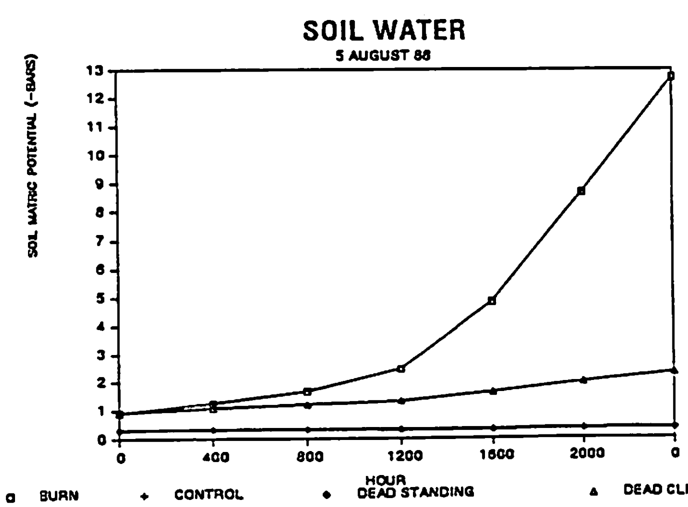

Figure 2.—Soil matric potential at 1-3 cm during a drying period after summer rains in a Lehmann lovegrass stand with the grass canopy intact and alive (control), intact but dead (dead standing) or removed by burning (burn) or clipping (dead clip).

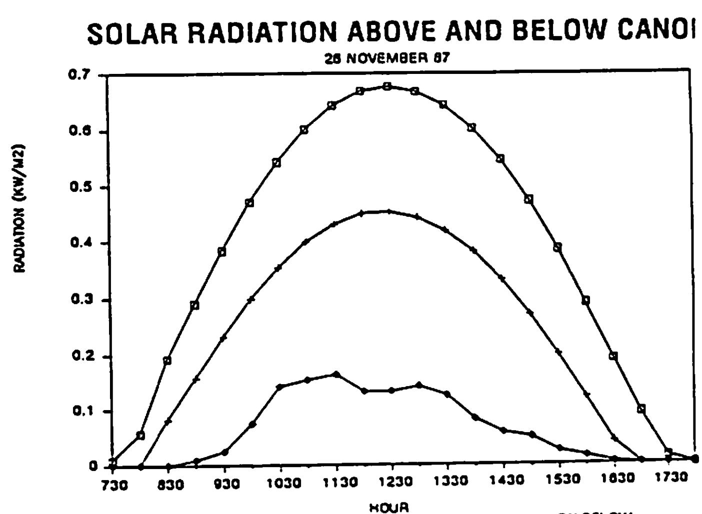

Figure 3.—Incident (RT) and net (RN) radiation above and below a Lehmann lovegrass canopy.

and clipped plots than plots with either a live (control) or dead canopy (dead standing) (fig. 2). Evidently, soil water was lost more to evaporation than transpiration, and soil water availability did not account for differences in seedling emergence.

The grass canopy affects both the quantity and quality of light reaching the seedbed. In November, when the canopy was senesced, net radiation at the top of the canopy was about 67% of the incident solar radiation, but net radiation under the canopy was less than 24% of the incident solar radiation (fig. 3). Thus, at least 33% of the incident radiation was reflected by the canopy while 43% of incident radiation went to heating the canopy and did not reach the seedbed. The lower input of energy to the seedbed resulted in lower soil temperatures and a smaller diurnal difference in soil temperatures where the canopy was intact than where it was removed by clipping or burning (figs. 4 and 5). The warmer seedbed and greater diurnal temperature differences on burned and clipped plots may have increased germinability of seeds in the seedbank, possibly by breaking down the seedcoat. Germination tests of newly harvested seed from this site indicated that only 5% were readily germinable but that an additional 45% would germinate when the seedcoat was mechanically scarified. A greater range in diurnal temperatures may increase germination of warm season grasses during optimum soil water conditions. Saltgrass *(Distichlis spicata)* requires a 20°C differential in diurnal temperatures for maximum germination (Cluff and Roundy 1988).

The grass canopy may also modify the quality of light reaching the seedbed during summer rains when temperature and soil water conditions are optimum for germination. Green leaves absorb strongly the red and blue wavelengths so that below-canopy light has a low red/far-red ratio (Bewley and Black 1982). Predominant red light may induce dormancy by changing the phytochrome ratio in the seed and may inhibit germination by reducing cell elongation in the radicle (Bewley and Black 1982).

The effects of quality of light and alternating temperatures on germination of Lehmann lovegrass are subjects for future research. The present study indicates that although heat from fire may directly increase germinability of Lehmann lovegrass, the removal of the canopy by fire is most responsible for increased seedling emergence after burning. These results also suggest that seedling establishment could be much greater in heavily-grazed than ungrazed stands of Lehmann lovegrass and are of use in determining how to manage for persistence or replacement of this exotic species.

Literature Cited

Bewley, J. D.; Black, M. 1982. Physiology and biochemistry of seeds. Vol. 2. Viability, dormancy and environmental control. Springer-Verlag, New York. 339 p.

Bock, C. E.; J. H. Bock, K. L.; Jepson; J. C. Ortega. 1986. Ecological effects of planting African lovegrasses in Arizona. National Geographic Research 2: 456-463.

Cable, D. R. 1971. Lehmann lovegrass in the Santa Rita Experimental Range, 1937-1968. J. Range Manage. 24: 17-21.Cluff, G.J.; Roundy, B.A. 1988. Germination responses of desert saltgrass to temperature and osmtic potential. J. Range Manage. 41: 150-152.

Cox, J. R.; Ruyle, G. B. 1986. Influence of climatic and edaphic factors on the distribution of *Eragrostis lehmanniana* Nees in Arizona, U.S.A. J. Grassl. Soc. S. Afr. 3: 25–29.

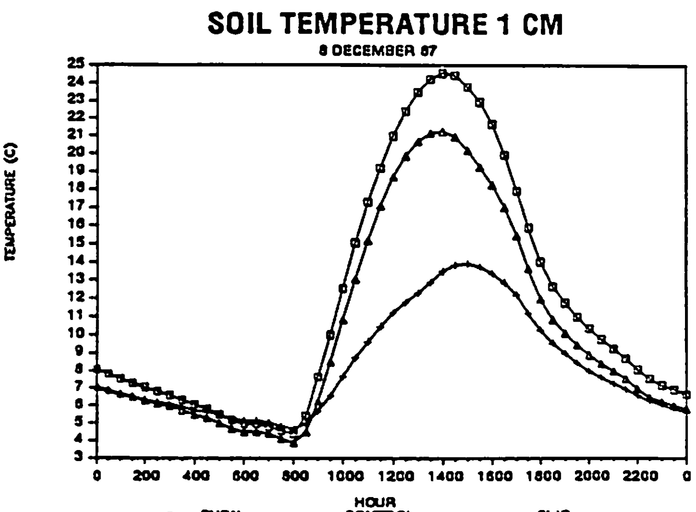

Figure 4.—Winter soil temperatures at 1-cm in a Lehmann lovegrass stand with the grass canopy intact (control) or removed by burning (burn) or clipping (clip).

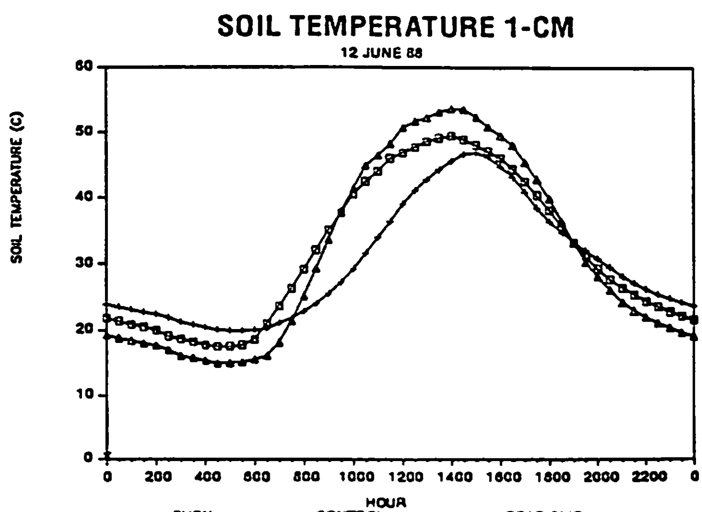

Figure 5.—Late spring soil temperatures at 1-cm in a Lehmann lovegrass stand with the grass canopy intact (control) or removed by burning (burn) or clipping (clip).

Ruyle, G. B.; Hasson, O.; Rice, R. W. 1987. The influence of residual stems on biting rates of cattle grazing *Eragrostis lehmanniana* Nees. Applied Animal Behavior Science 19: 11-17.

Ruyle, G. B.; Roundy, B. A.; Cox, J. R. 1988. Effects of burning on germinability of Lehmann lovegrass. J. Range Manage. 41: 404-406.