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The impact of a prescribed burn on introduced Lehmann lovegrass versus native vegetation in the northern Chihuahuan Desert

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Abstract

Prescribed burning has been suggested as a method to prevent shrub encroachment on desert grasslands. A concern for range managers is the prevalence of introduced African lovegrasses (*Eragrostis* spp.). These exotic grasses may compromise the effectiveness of fire as a range management tool in these areas due to their fire tolerance. In this study we examined the response of an established patch of Lehmann lovegrass to a prescribed burn. While Lehmann lovegrass was not adversely affected by the prescribed burn, all of the native grasses were compromised to some degree.

Keywords: Lehmann lovegrass; Invasive species; Desert grasslands; Prescribed fire; Chihuahuan Desert

1. Introduction

The northern Chihuahuan Desert is experiencing a dramatic loss of its grasslands, as are many arid and semi-arid lands in the world. In the mid-1800s, 58% of the area of the Jornada Experimental Range (JER), in south-central New Mexico, consisted of grassland devoid of shrubby vegetation. By the 1960s there were no upland grasslands at the JER free of shrubs (Buffington and Herbel, 1965). In an attempt to

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maintain the integrity of the remaining grasslands, the US Department of Agriculture–Agricultural Research Service (USDA–ARS) is conducting research on the effectiveness of prescribed burning to prevent shrub encroachment. This method has been recommended by some authors for arid rangeland management in southeastern Arizona because of high shrub-seedling mortality after burning (Humphrey, 1958; Bahre, 1991). Others, however, have warned that this may not be advisable due to the slow recovery of the important native grass, black grama (*Bouteloua eriopoda* Torr.) after burning (Wright, 1980). An additional concern for range managers is the prevalence of introduced African lovegrasses (*Eragrostis* spp.), which may compromise the effectiveness of fire as a range management tool in these areas due to their fire tolerance (Anable et al., 1992). The non-native Lehmann lovegrass (*Eragrostis lehmanniana* Nees.) is established in many of the remnant grasslands on the JER. The potential response of this species to burning needs to be considered in any range management program involving prescribed fire.

Lehmann lovegrass was imported from South Africa to Superior, Arizona in 1932, and was first introduced on the JER in 1938. Its drought-tolerance and ability to generate thick stands have made it a popular grass species for erosion control along newly constructed roadways and flood control projects. Additionally, it has been used in rangeland reseeding projects as a replacement forage for areas where the native grass species are disappearing. Since its introduction, however, Lehmann lovegrass has established itself and expanded its range out into the surrounding native grasslands. By 1984, in southeastern Arizona, it had more than doubled its range beyond where it was directly seeded (Cox and Ruyle, 1986). In areas where it has become established, Lehmann lovegrass has proven to be a highly competitive and invasive species. Anable et al. (1992) reported that Lehmann lovegrass was present on 85% of 75 plots across the Santa Rita Experimental Range (SRER) in southern Arizona, where it comprised >40% of the perennial grass plants. In some areas it made up >90% of the grass biomass. Bock et al. (1986) showed a serious decrease in most native plant species in the presence of Lehmann lovegrass, which has also been shown to cause a reduction in the local fauna (Bock et al., 1986; Whitford, 1997).

Lehmann lovegrass is a highly fire-tolerant species. Most research has shown it to recover quickly after burning (Cable, 1965; Pase, 1971; Martin, 1983), although some studies have shown a reduction in cover in response to fire (Bock and Bock, 1992). It has been proposed that areas where Lehmann lovegrass has become established may be at greater risk of fire because lovegrass generates greater quantities of fine fuels than do native grasses (Cox et al., 1990; Anable et al., 1992). These traits, combined with the highly competitive nature of Lehmann lovegrass, pose a risk of generating a positive-feedback cycle enhancing both the frequency of fires and the expansion of Lehmann lovegrass (Anable et al., 1992). Such a system has been documented with cheatgrass (*Bromus tectorum* L.) in the intermontane grasslands of the western United States (Mack, 1986) and other grass invasions throughout the world (D'Antonio and Vitousek, 1992).

Most information on Lehmann lovegrass comes from research in the desert grasslands of southeastern Arizona, primarily on the SRER. Few studies have been conducted on its ecology in the northern Chihuahuan Desert (but see

Fredrickson et al., 1997; Fernandez and Reynolds, 2000) and little is known about its response to fire in this region.

In this study we examined the response of an established patch of Lehmann lovegrass to a prescribed burn on the JER. We assessed how quickly it recovered from fire and whether burning affected the rate of expansion. Furthermore, we examined the response of the native vegetation within and surrounding this patch to the presence of lovegrass, as well as the effects of the prescribed burn on the native vegetation.

In addition to vegetation community parameters, we wanted to assess factors which may influence the local fire regime. We examined differences in the degree of patchiness of the perennial grass cover, litter generation and litter distribution between Lehmann-lovegrass-dominated areas and those dominated by native grasses. Increased spatial homogeneity of grass cover and greater litter accumulation can alter the local fire cycle by facilitating the spread of fire through an area. The value of prescribed fire in range management in semi-arid grasslands cannot be properly assessed without understanding the response of invasive species to treatments.

2. Methods

2.1. Study area

This research was conducted in Pasture 13 of the JER, located approximately 40 km NNE of Las Cruces, NM. This area is in the northern Chihuahuan Desert, in the Jornada del Muerto Basin. Pasture 13 covers 409 ha, the majority of which is semi-arid grassland. The dominant grasses are *B. eriopoda*, *Aristida* spp., and *Sporobolus* spp. Shrub encroachment is evident throughout the pasture, with *Prosopis glandulosa* Torr., *Ephedra trifurca* Torr., and *Yucca elata* Engelm. dominating. Mesquite coppice dunes have started to form in the SE and NE corners. A maintenance road for a Chevron Oil Company pipeline transects the pasture, running approximately N–S. An established patch of *E. lehmanniana* stretches for approximately 200 m along each side of the road. This pasture has been grazed at varying intensities since before the establishment of the JER in 1912. Cattle were excluded from the area from July 1998 until October 1999 when a light, year-round grazing regime was reinstated.

Meteorological data collected since 1929 (at a rain gauge located about 1 km north of the study site) report a mean annual precipitation of approximately 200 mm, with 55% of annual rainfall occurring from July 1 to September 30 in the form of convective thunderstorms. Lightning strikes from these thunderstorms are often responsible for initiating wildfires in desert grasslands.

2.2. Experimental treatment

In the fall of 1998, we marked a $175\,m \times 300\,m$ area encompassing the lovegrass patch and a portion of the surrounding native grassland. We established 12 transects within this site, six on each side of the pipeline road. The transects were systematically placed at 50 m intervals running E–W using a compass to determine the bearing. Transects on the east side of the road were 100 m long, while the ones on the west side were 75 m, with each transect beginning in the center of the road. The four northernmost were outside of the lovegrass patch, while the remaining eight traversed the patch and entered into the area dominated by native grasses. Adjacent transects were paired into six blocks, three on either side of the road. Within each block, one transect was randomly chosen to be burned, while the other was left as a control. Unburned buffer zones of 25 m were established on either side of each transect.

The study area was burned over the course of 3 days in May 1999. During the burn there was very low humidity and moderately high winds. A field crew of 3–6 technicians conducted the burn on foot, using backpack-mounted propane torches. Individual plants were briefly ignited by the torches. No attempt was made to re-ignite a plant if it failed to burn. Approximately 95% of the vegetative cover was burned on the treatment transects (based on visual estimate). Since the soil disturbance generated by burning the area is an inherent side effect of prescribed fires, no attempt was made to reproduce the soil disturbances in the control plots.

2.3. Vegetation cover measurements

Vegetation cover was visually estimated in 1 m × 1 m quadrats located every 2 m along the north side of each transect. This created 37 quadrats on each western transect and 50 on the eastern ones. For analyses of vegetation cover, one of the eastern blocks was excluded because one transect traversed the Lehmann lovegrass patch while the other did not.

Vegetation cover estimates were made using a 1 m × 1 m PVC frame which was divided into 10 cm × 10 cm sections using string. Each section, therefore, represented 1% of the quadrat. The frame was mounted on adjustable legs so it could be placed above the vegetation without altering the natural form of the plants.

Within each quadrat, we visually estimated total cover for all perennial plant species. The lowest possible cover was 0.1%, while greater covers were estimated in 0.25% increments. We measured annual forbs and grasses with density instead of cover. Due to the large number of forbs and annual grasses present, we only measured these species in the 25 cm × 25 cm corner of the quadrat that was closest to the transect and the origin. For perennials, all cover that fell within the quadrat was measured. For annuals, however, only those plants that were rooted inside the quadrat were recorded.

We completed pre-burn measurements in the fall of 1998 and post-burn measurements in the fall of 1999 and 2000. When possible, every plant was identified to species (grass identifications were based on Allred, 1993; all other taxa were based on Correll and Johnston, 1970). All plants were identified to at least the generic level. Of the native perennial grasses, the three-awns (*Aristida* spp.) and dropseeds (*Sporobolus* spp.) were not identified beyond genus due to the difficulty in accurately determining the species when the plant is not in flower.

2.4. Vegetation point measurements

We also examined the spatial distribution of vegetation and litter to assess potential impacts of Lehmann lovegrass on the fire cycle. To do this, we took point measurements within a set of quadrats within the lovegrass patch, completely outside the patch, and in the adjacent transition area. These measurements were only conducted along the belt transects in the three blocks where both transects traversed the lovegrass patch.

The transects were divided into three zones: a Lehmann lovegrass zone within the main patch of the lovegrass, a native grass zone, and a transition zone where the native and invasive grasses were in contact. Within each zone, block, and treatment, four quadrats were chosen at random for a total of 72 quadrats. In each quadrat, 41 point measurements were taken. The points were determined by the intersection of the strings of the PVC frame described above, at which a straight wire was dropped to the ground. Every perennial plant touched by the wire was recorded as a "hit". The ground cover (i.e. bare ground, litter or root crown) contacted was also recorded. These measurements were completed in the spring of 1999, before the burn, and the fall of 2000.

2.5. Litter measurements

Litter was collected in the same quadrats used for the vegetation point measurements. From the 41 points in each quadrat, three were selected at random for each sampling period. If a point was selected for sampling, that point was then excluded from successive sampling periods. At each point, litter was collected from a 5-in diameter circle. Samples were collected in mid-April 1999, immediately before the burn, and in mid-September 2000. Litter samples were sieved with a 2 mm sieve to remove soil, air-dried, and then weighed to the nearest hundredth of a gram.

2.6. Statistical analysis

All statistical analyses were conducted using SAS (SAS Institute, 1999). Analysis of variance was performed using the PROC MIXED procedure. Data were analysed as a Randomized Complete Block Design with a split plot in time. We tested the mean vegetative cover response to the factors of year and burn-treatment, and the year-by-treatment interaction. Analysis was conducted separately on each of the dominant species (*E. lehmanniana*, *B. eriopoda*, *Aristida* spp., *Sporobolus* spp., *Xanthocephalum sarothrae* (Pursh) Shinners, *Croton pottsii* (Klotzsch) Muell.-Arg., *Solanum elaeagnifolium* Cav.) as well as various functional groups (native perennial grasses, annual grasses, annual forbs, perennial forbs). In addition, the analysis of variance model for each dominant species, excluding Lehmann lovegrass, and functional group contained percent cover of Lehmann lovegrass as a co-variate. Least-square means were also calculated for burn treatment. Means for the native species were adjusted for the lovegrass co-variate, while means for Lehmann lovegrass were unadjusted. Years were compared for each species and functional group using LSD pairwise comparisons. We also compared the number of quadrats per transect in which Lehmann lovegrass was detected across years and treatment to determine if there was a change in the spatial distribution of the species. Finally, we compared the response of each species to the treatment in transects which traversed the Lehmann lovegrass patch with those that did not traverse it (fixed effect = "Patch").

Analyses of variance were performed on the vegetation point measurements for the fixed effects of vegetation zone and treatment for each response (canopy cover, litter distribution, etc.). Zones were compared using LSD pairwise comparisons. Analysis of variance for the litter weights was complicated by non-normal distribution of the data. Data were pooled within zones and log transformed for the analysis.

3. Results

Canopy cover within the established patch of Lehmann lovegrass (as measured in May 1999, immediately prior to the burn) was nearly twice that of the areas dominated by native grasses (Table 1). During the prescribed burn, the thicker canopy allowed the lovegrass-dominated areas to burn more quickly and with fewer ignitions than the surrounding native grass area. Generally, in solid stands of lovegrass the fire would catch after igniting the first plant and carry across the entire patch. Burning native grass areas required walking to each small patch of grass and lighting it. The fire would rarely travel more than a few meters before it would reach a bare area too wide for it to cross. There were two exceptions to this. One was in the northeast corner of the site and the other was in a rill in the southeast part of the

Table 1
Average percent cover of perennial vegetation canopy per quadrat, percent cover per quadrat of soil-level responses and litter weight per quadrat ± standard error

Parameter	Lehmann lovegrass zone	Transition zone	Native grass zone
Canopy cover (%)	59.2 ± 5.79^{a}	42.0 ± 5.79^{b}	35.4 ± 5.79^{b}
Bare soil (%)	21.7 ± 4.48^{a}	30.1 ± 4.48^{ab}	35.1 ± 4.48^{b}
Litter cover (%)	60.7 ± 4.79^{a}	57.2 ± 4.79^{a}	54.6 ± 4.79^{a}
Root crown cover (%)	17.6 ± 2.39^{a}	12.7 ± 2.39^{ab}	10.7 ± 2.39^{b}
Litter weight (g)	4.84 ± 0.70^{a}	3.29 ± 0.70^{ab}	2.55 ± 0.70^{b}

Means within a row with a superscript of the same letter are not significantly different at $\alpha = 0.05$. Significance was determined by LSD pairwise comparison of the least-square means. Data for canopy cover, bare soil, litter cover, and root crown cover were collected in May 1999, prior to the burn (df. = 2, 10). Data for litter weight were collected in May 1999, prior to the burn and October 2000 (df. = 2, 10), two growing seasons after the burn. The litter weights presented are the means of the two sampling periods. *Note*: the litter weights presented in this table are the non-transformed data. The weights were log transformed to achieve a normal distribution. The log-transformed data showed the same pattern in detecting significant differences as the non-transformed data.

pasture, where the fire carried across Transect 6E. Both sites were areas where water collects and the native grasses are thick.

3.1. Vegetation cover measurements

The average percent cover per quadrat of Lehmann lovegrass did not differ between treatments or years, nor was there a significant interaction between these factors (Table 2; Fig. 1). Conversely, the treatment by year interaction was significant for every native perennial grass species, as well as for native perennial grasses as a functional group (Table 2). All of the native perennial grasses examined showed a reduction in cover in response to the burn (Table 2). The effect of fire was most dramatically seen in black grama (*B. eriopoda*), which was the only perennial grass to have a lower average percent cover in the treatment plots, the first year after burning, in spite of higher-than-average monsoon rains in 1999 (Fig. 2). Cover of snakeweed (*X. sarothrae*) was also significantly reduced by the burn and had not recovered by the end of the second post-burn growing season. The only taxa to increase after the burn were annual grasses and the perennial forb *S. elaeagnifolium*.

There was a significant increase in the number of quadrats per transect on which Lehmann lovegrass was present. The difference between 1998 ($M = 25$) and 1999 ($M = 28$) was significant ($t = -2.52$, $p > |t| = 0.0453$), but between 1999 ($M = 28$) and 2000 ($M = 29$) was not ($t = 0.52$, $p > |t| = 0.6249$). There was no detectable difference in expansion of lovegrass area between burned and unburned transects ($F = 1.11$; df. $= 1, 3$; $p > F = 0.3693$). The majority of the range expansion occurred

Table 2
Results of ANOVA for the fixed effect of the interaction between treatment and year (df. $= 2, 6$)

Sp. or functional group	1998		1999		2000		Treatment-by-year interaction	
	Burn	Control	Burn	Control	Burn	Control	F value	$p > F$
Aristida spp.	2.4±1.7	3.7±1.7	5.1±1.7	10.3±1.7	3.8±1.7	8.3±1.7	9.97	0.0124
B. eriopoda	3.6±1.1	6.3±1.1	2.0±1.1	9.0±1.1	2.6±1.1	8.9±1.1	14.01	0.0055
E. lehmanniana	4.6±1.8	2.8±1.8	4.7±1.8	5.5±1.8	4.9±1.8	5.6±1.8	1.48	0.3013
Sporobolus spp.	1.6±0.5	2.2±0.5	2.8±0.5	6.5±0.5	1.7±0.5	3.1±0.5	21.85	0.0018
Native perennial grasses	7.8±1.5	12.8±1.5	10.4±1.5	27.0±1.5	16.1±1.5	21.2±1.5	34.41	0.0005
C. pottsii	0.8±0.4	1.3±0.4	1.2±0.4	1.1±0.4	0.7±0.4	0.5±0.4	2.13	0.1995
S. elaeagnifolium	1.2±0.04	1.7±0.04	2.7±0.04	1.9±0.04	0.1±0.04	0.1±0.04	9.95	0.0124
Perennial forbs	1.2±0.3	1.7±0.3	2.7±0.3	1.9±0.3	1.1±0.3	0.9±0.3	4.86	0.0556
Annual grasses	0.0±1.3	0.0±1.3	2.3±1.3	0.9±1.3	14.9±1.3	5.3±1.3	10.51	0.0110
Annual forbs	4.4±2.5	0.0±2.5	3.2±2.5	1.7±2.5	4.8±2.5	2.5±2.5	0.22	0.8055
X. sarothrae	4.1±0.6	4.4±0.6	0.8±0.6	7.5±0.6	0.5±0.6	3.3±0.6	42.09	0.0003

Average percent cover per quadrats is given for each perennial species±SE for treatment and control in each year. Data for annual grasses and annual forbs are the average count per quadrat±SE for treatment and control in each year.

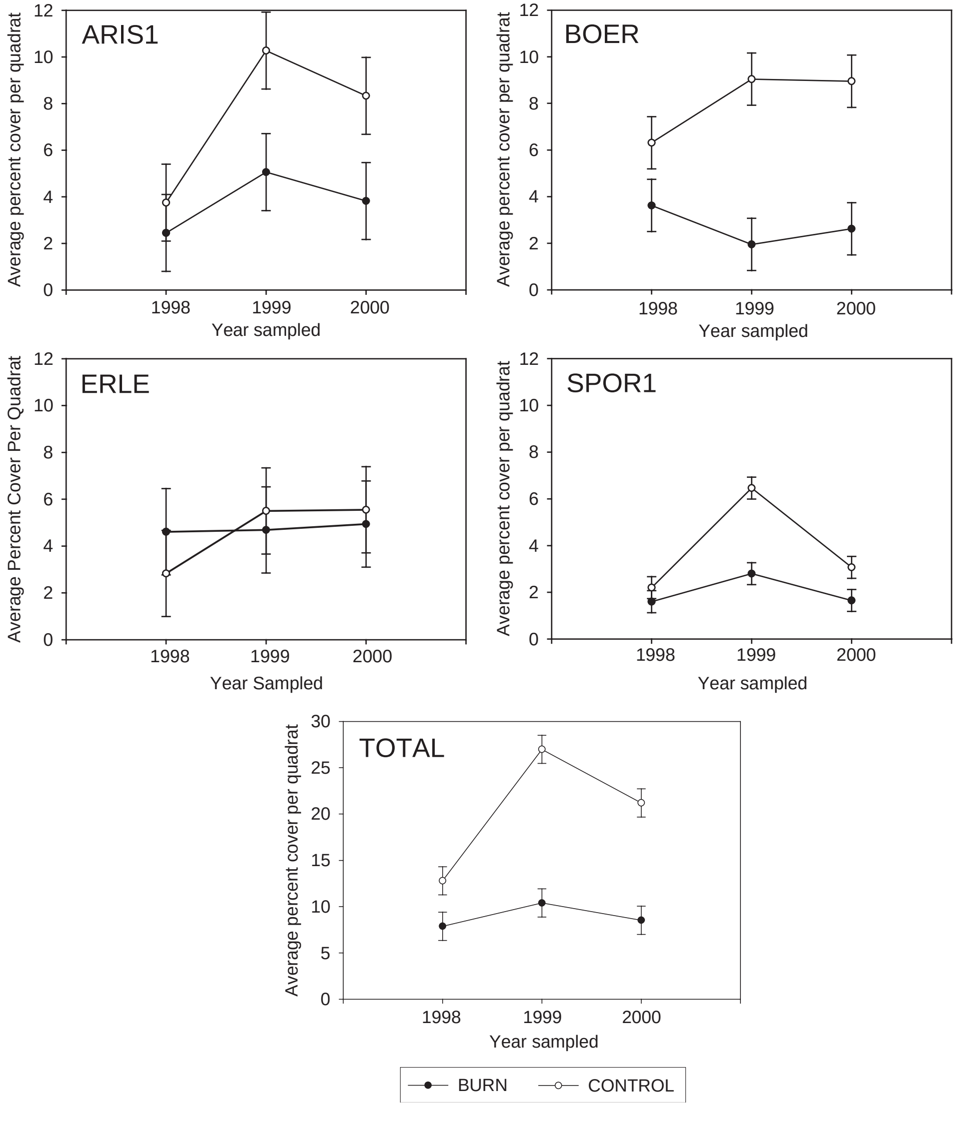

Fig. 1. Comparison of average percent cover per quadrat of perennial grass species before the burn (1998) and after recovery (1999 and 2000) in treatment and control transects. ERLE: *Eragrostis lehmanniana*; ARIS1: *Aristida* spp.; BOER: *Bouteloua eriopoda*; SPOR1: *Sporobolus* spp.; TOTAL: all native perennial grasses combined.

on the northeast side of the lovegrass patch. This is leeward of the prevailing winds during the monsoon season.

All species showed a reduction of cover or frequency as the amount of Lehmann lovegrass cover increased, except for silver-leafed nightshade (*S. elaeagnifolium*) which showed no significant response (Table 3). Additionally, all four functional

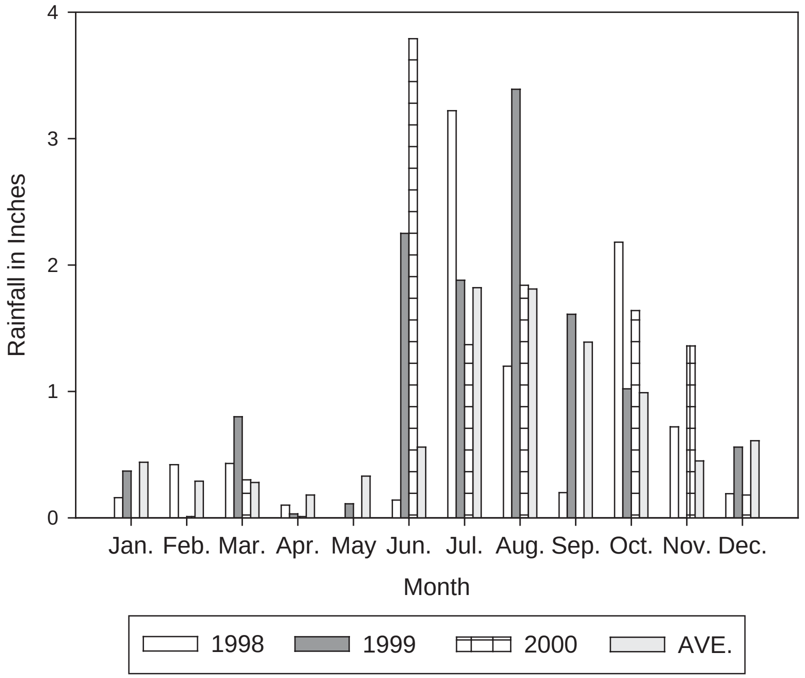

Fig. 2. Average monthly rainfall data on Pasture 13 of the JER for 1998, 1999, and 2000 as compared to the average (AVE). Average is based on monthly rainfall from 1929 to 2000.

Table 3
Response of average percent cover or count per quadrat of native plant species to percent cover of Lehmann lovegrass

Species or functional group	Estimated slope coefficient	*F* value	*p* > *F*
Aristida spp.	−0.05 ± 0.02	5.77	0.0166
B. eriopoda	−0.08 ± 0.03	8.75	0.0032
Sporobolus spp.	−0.07 ± 0.01	27.65	< 0.0001
Native perennial grasses	−0.19 ± 0.03	32.67	< 0.0001
C. pottsii	−0.01 ± 0.005	4.42	0.0359
S. elaeagnifolium	0.001 ± 0.001	0.91	0.3407
Perennial forbs	−0.01 ± 0.01	4.58	0.0327
Annual grasses	−0.12 ± 0.02	32.64	< 0.0001
Annual forbs	−0.12 ± 0.03	16.36	< 0.0001
X. sarothrae	−0.07 ± 0.02	18.28	< 0.0001

Estimated slope coefficient refers to the change in percent cover or count of plant species for every increase of 1% in Lehmann lovegrass cover.

groups tested had a lower average percent cover as the amount of Lehmann lovegrass cover increased (Table 3).

Finally, no native perennial grass species showed a significant response to the fixed effect of ''Patch'' at $\alpha = 0.05$. This compared the transects that traversed the

Lehmann lovegrass patch versus those that did not. The only significant response was for Lehmann lovegrass ($F = 6.74$; df. = 1, 3; $p > F = 0.08$).

3.2. Vegetation point measurements

Mean total canopy cover per quadrat was greater in the Lehmann lovegrass zone than that in the transition zone or native grass zone, while the transition and native grass zones did not differ (Table 1). Conversely, the amount of bare soil per quadrat in the Lehmann lovegrass zones was markedly lower than in the native zones, while the Lehmann lovegrass and native grass zones were indistinguishable from the transition zone. The same pattern held true when examining the percent of ground occupied by root crown. For none of these responses there was a significant difference detectable between the burned and control plots within each zone (Table 1).

3.3. Litter analysis

No significant difference was detected in the spatial distribution of litter between vegetation zones (i.e. the cover of the litter was viewed independent of the quantity of litter). A significant difference was, however, detected in litter weight between treatments ($F = 8.74$; df. = 1, 10; $p > F = 0.0144$) and between years ($F = 4.49$; df. = 2, 10; $p > F = 0.0406$). There was nearly twice as much litter collected from the lovegrass zones (4.84 ± 0.70 g) as from the native zones (2.55 ± 0.70 g). Litter weight from the transition zones was indistinguishable from that from the native or lovegrass zones (Table 1). The litter weight data were log transformed to achieve a normal distribution. The non-transformed data showed the same trends for the fixed and main effects. The non-transformed data are presented in Table 1.

3.4. Climate data

Precipitation data from 1998 to 2000 were collected from a rain gauge located approximately 1 km north of the study site. The first post-burn growing season (1999) had higher than average monthly rainfall from June to September, followed by lower than average rainfall from November to May 2000 (Fig. 2).

4. Discussion

4.1. Response to fire

The fact that Lehmann lovegrass did not increase in cover after the prescribed burn on the JER runs contrary to previously published research. After a fire in June 1963 on the SRER, there was a six-fold increase of the number of lovegrass plants in areas where the species was already established and a three-fold increase of lovegrass in areas originally dominated by black grama after the end of the first post-fire growing season. No new black grama seedlings were discovered on the site (Cable, 1965). Another study on the SRER showed little difference in densities of lovegrass 1 year after the burn, but then saw a five-fold increase in the second year (Martin, 1983). The response of black grama in this second study was inconsistent, with some plots showing no change after 4 years and others showing a reduction in density to as little as 10% of pre-burn levels. In both of these studies, however, frequency was used as a response (as opposed to cover), making it difficult to compare with our study. It is notable, however, that in both these studies, as well as ours, black grama performed markedly worse than Lehmann lovegrass. Other studies have reported similar findings for lovegrass, but did not monitor the response of black grama (Humphrey and Everson, 1951; Pase, 1971). In a study that did measure changes in cover after burning, both native grasses and lovegrass showed reduced cover for both years observed (Bock and Bock, 1992). Wright (1980) cited the poor post-burn performance of black grama as reason for not using prescribed fire as a range management tool on grasslands where it is the dominant species. In a study on the JER, Cornelius (1988) detected a very slow recovery for black grama, compared to a more rapid recovery by snakeweed and the shrub *E. trifurca*, suggesting that burning may actually enhance desertification of arid grasslands.

4.2. *Effects on fire cycle*

While fire may show no appreciable impacts on Lehmann lovegrass, there is a potential for lovegrass to affect the local fire cycle. D'Antonio and Vitousek (1992) stress that grass invasions can dramatically alter the fire regime of a region due to increases in fuel load, greater flammability, and the ability to recover quickly after a fire. This positive feedback has been documented with cheatgrass (*B. tectorum*) in areas of Idaho and Oregon. Fire cycle intervals have dropped from an estimated 60–110 years prior to invasion to the 3–5-year intervals seen currently (Mack, 1986). Anable (1990) reported an increase in the frequency of fires along roadsides of the SRER where lovegrass is present.

Lehmann lovegrass has many properties that may encourage an elevated fire regime. Net annual above-ground primary production increases when lovegrass dominates a site (Anable et al., 1992), and is as much as four times higher in pure lovegrass stands than in sites where the native grasses have persisted (Cox et al., 1990). This leads to large quantities of flammable standing-dead biomass during the dry season preceding the summer monsoons (Cox et al., 1990).

While our study detected no difference in the spatial distribution of litter between the lovegrass-dominated areas and those dominated by native grasses, quantities of litter were higher in the lovegrass patch. This would provide greater quantities of fuel for fire in the lovegrass patch. Furthermore, the results of this study show reduced patchiness of the canopy cover in lovegrass-dominated areas, suggesting that fire would be able to spread more easily within a lovegrass patch than in native grasslands. This was supported by visual observations made during the prescribed burn. Fire spread more quickly and easily through the lovegrass patch than in the surrounding areas dominated by native grasses. Further anecdotal evidence was obtained during a series of arson fires which were set in 2000 on the JER and adjacent New Mexico State University and Bureau of Land Management property. The fires that carried farthest across the landscape were those set in areas dominated by Lehmann lovegrass (J. Anderson, pers. comm.).

4.3. Effects on community dynamics

The impact of Lehmann lovegrass on the plant community in the Jornada Basin, as seen in this study, is similar to that documented in Arizona. Lovegrass-dominated areas have lower diversity and abundance of native plant species than adjacent areas dominated by native grasses. It is likely that here, as elsewhere, in areas reduced to nearly pure lovegrass, changes in trophic interactions between plants and herbivores and changes in the physical structure of the vegetation could have a detrimental effect on the local fauna (Bock et al., 1986; Williamson, 1996). Bock et al. (1986) reported a decline in native vegetation in the presence of Lehmann lovegrass similar to that seen in this study, as well as a reduction in animal biodiversity. Of the 43 plant and animal species they examined, 26 (10 plant, 5 bird, 3 rodent, 8 grasshopper) were shown to be significantly more abundant in the native grasslands, while only Botteri's sparrow (*Aimophila botterii*), the hispid cotton rat (*Sygmodon hispidus*), and the grasshopper species *Phoetaliotes nebrascensis* were shown to have significantly higher numbers in areas dominated by exotic grasses. Whitford (1997) reports a reduction in diversity of breeding birds in lovegrass versus native grass areas, while Medina (1988) reported that scaled quail (*Calipela squamata*) were more prevalent in native grass sites than in ones dominated by lovegrass. It is reasonable to expect a similar trend in areas dominated by Lehmann lovegrass in southern New Mexico.

4.4. Implications for range management

While we observed no direct response of Lehmann lovegrass to burning, there is indirect evidence suggesting that fire may promote its spread. The ability of lovegrass to recover more quickly from fire than native grasses creates the potential for greater seed production in the first post-burn growing season. Furthermore, lovegrass seed germinates at a higher rate in burned areas than unburned (Ruyle et al., 1988; Sumrall et al., 1991), enhancing propagule pressure on the surrounding native vegetation. There are currently well-established lovegrass populations in several areas of the JER and adjacent properties. This provides numerous loci for seed generation and dispersal.

These concerns about lovegrass invasion are exacerbated by the relatively slow recovery of the native grasses. Since lovegrass recovers more rapidly than native grasses after burning, lovegrass has more potential to generate and disperse seeds in the first growing season after the fire. This may skew the seed bank in favor of Lehmann lovegrass for future generations of seedlings. It is conceivable, therefore, that this study was not long enough (two post-burn growing seasons) to detect the full impact of the fire on Lehmann lovegrass invasion. Longer-term monitoring of the research area is necessary for comprehensive assessment of the full impact of prescribed burning on the invasiveness of Lehmann lovegrass.

The highly competitive nature of lovegrass is also a concern for prescribed burning in Chihuahuan Desert range management. Past studies have shown that disturbances can facilitate persistence of invasive species in sites with established populations (Hobbs and Huenneke, 1992). The rapid recovery rate of lovegrass after burning combined with its ability to out-compete most native grasses may promote the exclusion of native species in areas where lovegrass is currently established. The cumulative effect of these factors calls into question the feasibility of using prescribed burning to manage desert grasslands where this invasive species occurs in the landscape.

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