Response of Lehmann Lovegrass to Time of Fertilizer Application

BAHE BILLY, J. L. STROEHLEIN, AND P. R. OGDEN

Highlight: *On a desert grassland site in southern Arizona, production of Lehmann lovegrass (*Eragrostis lehmanniana*) was significantly increased by applications of 30-10-0 fertilizer as late as July 22. Seed yields were least with later dates of fertilization. Nitrogen and phosphorus contents of the plants were increased within 1 week after application; thereafter they generally declined. Nitrate-nitrogen and available phosphate in the surface 4 inches of soil increased immediately after fertilization, and the nitrate-nitrogen then decreased rapidly. Plots fertilized at later dates generally reached their peak yield and higher nitrogen and phosphorus contents later and remained greener into the fall months than those fertilized at the beginning of the rainy season. Herbage growth of forbs the following spring was greater on fertilized plots than on control plots, but data were very variable and not significant. No residual response of Lehmann lovegrass was found the second summer growing season after fertilization, probably a result of the dry summer.*

The use of fertilizer is indispensable for irrigated pastures in Arizona, but it has not become a standard practice on nonirrigated ranges.

A satisfactory response to fertilizer has been obtained on some native grass ranges (Ogden et al., 1967; Stroehlein et al., 1965) and on seeded Lehmann lovegrass (*Eragrostis lehmanniana*) ranges (Holt and Wilson, 1961; Stroehlein et al., 1968). Usually, however, fertilization of ranges is not justified (Freeman and Humphrey, 1956; Honnas et al., 1959; Stroehlein et al., 1968). Lack of satisfactory response is attributed to factors such as poor stand of desirable grasses, insufficient rainfall, loss of nitrogen through leaching or other means, and improper time of fertilizer application.

Fertilization after summer rains have begun reduces the risk of insufficient rainfall and nitrogen loss and increases production over earlier or later treatment (Stroehlein et al., 1968). Since Lehmann lovegrass is easily seeded on ranges in poor condition (Humphrey, 1960) and fertilization increases the yield and quality (Holt and Wilson, 1961), additional information is needed on the effects of time of fertilization on the growth of this important grass.

Study Area and Methods

The study was conducted at the Page-Trowbridge Experimental Range, 28 miles north of Tucson, Ariz. The elevation is approximately 3,680 ft. The site had a very good stand of Lehmann lovegrass with some Boer lovegrass (*E. chloromelas*) among scattered mesquite (*Prosopis juliflora*). The soil is a Whitehouse sandy loam, fine, mixed, thermic family of Ustollic Haplargid.

The mean annual rainfall is approximately 15 inches. Slightly over 50% is expected during the July to September summer season. Rainfall at the site during the 1967 growing season was 2.00 inches in June, 1.89 for July, 4.43 in August, and 1.00 in September. Total rainfall for these months during 1968 was only 2.49 inches.

Treatments consisted of five dates of application and an unfertilized control arranged in a completely random design with five replications. Plot size was 20 by 30 ft. Granular ammonium nitrate-phosphate (30-10-0) supplied by the Tennessee Valley Authority was broadcast at a rate of 50 lb N/acre on plots where the grass had been mowed to a 2-inch stubble height.

Lovegrass was harvested on August 19, September 13, and October 12, 1967. One-third of the plot was randomly chosen for clipping. Two strips 35 inches wide and 18 ft long were cut with a power mower to a 2-inch stubble height. All the clipped forage was weighed, and a subsample taken for moisture and chemical analyses. The forage from one of the mowed strips was thrashed to determine seed yields.

Samples were collected regularly in 1967 prior to harvest as well as at harvest time to assess the N and P levels of the plants and the available soil nitrate and

Table 1. Average herbage production (lb/acre, oven dry) of Lehmann lovegrass, fescue, and forbs, and seed production (lb/acre) of Lehmann lovegrass at indicated harvest dates resulting from 30-10-0 fertilizer applied on five different dates during 1967, Page Trowbridge Ranch.[1]

Application date	Harvest date						
	Lehmann lovegrass					Forbs	Fescue
	Herbage				Seed		
	8/19/67	9/13/67	10/12/67	10/16/68	10/12/67	4/4/68	4/4/68
June 5	1,550a[2]	1,480a	1,550a	330	57a	327	745
July 3	1,400a	1,290a	1,520a	440	51ab	416	307
July 12	1,340a	1,350a	1,500a	340	48ab	358	305
July 22	700b	870a	1,240a	330	34bc	283	264
August 7	600bc	660bc	940b	250	30c	615	463
Check	400c	440c	560c	270	21c	206	51

[1] Average of five replicates.
[2] Values followed by the same letter are not significantly different ($P = 0.01$). Differences in columns without letters are not significant at $P = 0.05$.

The authors are former graduate assistant and associate professor, Department of Soils, Water and Engineering, and professor of range management, Department of Watershed Management, University of Arizona, Tucson.

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phosphate. Ten plants were randomly collected from each treated and control plot at each date for moisture and chemical analyses. Five soil cores 4 inches in depth were taken from each plot at each sample date.

Spring annuals may be stimulated by fertilization the previous summer, reducing any carryover effect on the perennial grass. Annuals were harvested in the spring of 1968 by hand clipping two 9.6 ft^2 subplots on each plot. These were separated into six weeks fescue (*Vulpia octoflora*) and forbs, with Indian wheat (*Plantago purshii*) making up the bulk of the latter. Lehmann lovegrass was harvested by mowing strips on October 16 to determine residual influence of fertilization the second growing season.

Results and Discussion

Lehmann lovegrass herbage production (Table 1) was highest with the earliest date of application, June 5, although this was not significantly different from applications through July 12 for the second and third harvests. Fertilization on June 5 produced faster growth and an earlier maximum growth than later dates, but fertilization may be delayed until after some accumulation of soil moisture with summer rains and still obtain satisfactory results to fertilization. For all dates of application, fertilizers significantly increased production over check plots at the final harvest. Seed production was increased significantly by fertilization at the earliest application dates and then decreased with lateness of application (Table 1).

Nitrogen content of lovegrass had increased significantly by each sample date after fertilizer application (Table 2). The N content of the plants generally reached a peak after fertilizer application, then declined. Herbage harvested from fertilized plots in October produced four times as much protein as the nonfertilized plots. Later fertilization dates extended improved protein quality of the grass into the fall season. The N content of plants from the control reached a peak in late July and then declined. The phosphorus contents of the plants also were increased by fertilization (Table 3). The same general trends were found as with the N contents.

There was greater annual fescue and forb growth on fertilized plots compared to control plots the spring of 1968 (Table 1). The growth of fescue on these plots was five to twelve times that of the check plot; differences were significant only at the 10% level. Although annual fescue provides some forage during the spring, it is questionable if any increased production would be an efficient use of fertilizer. The dry summer of 1968 resulted in low Lehmann lovegrass herbage yield and insignificant differences among treatments when harvested in October of 1968.

The nitrate content of the surface 4 inches of soil generally was greater on fertilized plots compared to control plots for all sample dates in 1967 (Table 4). Low soil nitrate values were found for the surface 4 inches of soil in September and October; thus, little residual N was available in the surface soil after the first summer growing season. The increased N contents and herbage yield of the harvested Lehmann lovegrass plants indicate that about half of the N applied was taken up by plants the first summer growing season.

Available soil phosphate was increased two-to three-fold by fertilizer application (Table 5). The fact that phosphate availability increased was shown also by the plant P content. Soil analysis showed no trend toward decreasing phosphate availability throughout the season, meaning that the decrease in plant P was probably only the expected natural decline with plant maturity.

Conclusions

During a year of above average rainfall, herbage yields of Lehmann lovegrass were tripled by fertilizer application. There were no significant differences among herbage yields obtained from fertilizer applications from June 5 to July 12. In previous studies with native grasses and Lehmann lovegrass, yields have generally been better when fertilized after the first summer rains, or about July 20 in this area. (Stroehlein et al., 1968). The difference in rainfall between the different years may account for the slightly dif-

Table 2. Nitrogen content (%) of Lehmann lovegrass at 6 sampling dates by dates of fertilization with 30-10-0 fertilizer. Page-Trowbridge Ranch, 1967.[1]

Application dates	Sampling dates					
	July 3	July 22	Aug. 7	Aug. 19	Sept. 13	Oct. 12
June 5	1.93a[2]	2.37a	1.55b	1.66a	1.06a	0.97a
July 3	–	2.49a	1.89ab	1.56a	0.97a	1.05a
July 12	–	2.62a	2.16a	1.59a	1.16a	1.06a
July 22	–	–	1.87ab	1.80a	1.13a	1.19a
August 7	–	–	–	1.88a	1.23a	1.30a
Control	1.27b	1.58b	1.04c	1.05b	0.52b	0.59b

[1] Average of five replicates.
[2] Values followed by the same letter are not significantly different ($P = 0.01$).

Table 3. Phosphorus content (%) of Lehmann lovegrass at 6 sampling dates by dates of fertilization with 30-10-0 fertilizer. Page-Trowbridge Ranch, 1967.[1]

Application dates	Sampling dates					
	July 3	July 22	Aug. 7	Aug. 19	Sept. 13	Oct. 12
June 5	0.21	0.32[2]	0.25ab[3]	0.26ab[4]	0.12ab[3]	0.11b[4]
July 3	–	0.32	0.29a	0.25ab	0.13ab	0.11b
July 12	–	0.29	0.30a	0.25ab	0.14a	0.11b
July 22	–	–	0.30a	0.27a	0.10bc	0.13ab
August 7	–	–	–	0.27a	0.13ab	0.14a
Control	0.21	0.31	0.23b	0.24b	0.08c	0.12ab

[1] Average of five replicates.
[2] Differences in columns without letters following the values are not significant at the $P = 0.05$ level.
[3] Values followed by the same letter are not significantly different at the $P = 0.01$ level.
[4] Values followed by the same letter are not significantly different at the $P = 0.05$ level.

Table 4. Nitrate-nitrogen concentration (ppm) of the soil at 6 sampling dates by dates of fertilization with 30-10-0 fertilizer. Page-Trowbridge Ranch, 1967.[1]

Application dates	Sampling dates					
	July 3	July 22	Aug. 7	Aug. 19	Sept. 13	Oct. 12
June 5	26.5a[2]	21.2a[2]	19.5a[2]	10.2ab[2]	4.6[3]	4.3[3]
July 3	–	11.1b	5.9b	3.8b	4.3	5.6
July 12	–	23.1a	10.0b	7.4ab	4.6	5.6
July 22	–	–	12.9a	8.9ab	4.0	8.0
August 7	–	–	–	14.0a	6.0	7.8
Control	3.6b	5.9b	3.9b	4.4b	3.4	3.4

[1] Average of five replicates.
[2] Values followed by the same letter are not significantly different at the $P = 0.01$ level.
[3] Differences in columns without letters following the values are not significant at the $P = 0.05$ level.

Table 5. Available soil phosphate (ppm PO_4), at 6 sampling dates by dates of fertilization with 30-10-0 fertilizer. Page Trowbridge Ranch, 1967.[1]

Application dates	Sampling dates					
	July 3	July 22	Aug. 7	Aug. 19	Sept. 13	Oct. 12
June 5	6.9a[2]	11.5a[2]	7.1a[2]	9.0a[2]	11.4a[3]	9.5a[3]
July 3	–	7.9b	8.6a	7.7a	9.9a	11.0a
July 12	–	10.8a	9.6a	8.3a	10.1a	9.6a
July 22	–	–	8.5a	8.9a	11.7a	12.1a
August 7	–	–	–	5.9ab	12.0a	12.2a
Control	4.4b	5.8b	3.5b	3.9b	6.8b	4.1b

[1] Average of five replicates.
[2] Values followed by the same letter are not significantly different at the $P = 0.01$ level.
[3] Values followed by the same letter are not significantly different at the $P = 0.05$ level.

ferent results. Fertilizer should not be applied to range grasses until sufficient rainfall and the plants begin to grow. This same principle is used by midwestern farmers in the United States when planning their fertilizer program for corn. The supply of subsoil moisture is considered at planting and fertilizing time and the fertilizer rate is adjusted accordingly. In the case of range grass, some soil moisture, provided by the first summer rains, would insure future grass growth and prevent unnecessary use of fertilizers during a dry year.

These data also indicate, as in other studies, that later fertilization can produce higher quality feed for fall grazing. This is particularly important for Lehmann lovegrass which is best utilized in the fall because it makes good growth and remains green later than native grasses that grow on dry Southwestern ranges.

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THESIS: COLORADO STATE UNIVERSITY

Responses of Shortgrass Range and Blue Grama (*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.) Plants to S-triazine Herbicides, D. H. van der Sluijs, PhD, Range Management. 1972.

Periodical and seasonal fluctuations in forage quality and quantity constitute one of the basic problems in range management. Forage quality and quantity are usually inversely related. S-triazine herbicides possess growth-regulating properties that may influence these characteristics simultaneously.

Field experiments were carried out in northern Colorado to study the effect of three s-triazines on dry matter yield, crude protein content, nitrate N content, and soluble sugar content of shortgrass range herbage. Herbicides used, in decreasing order of water-solubility, were Bladex [2-(4-chloro-6-ethylamino-1,3,5-triazine-2-ylamino)-2-methyl-proprionitrile], atrazine [2-chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine] and simazine [2-chloro-4,6-bis(ethylamino at 1.12 and 3.36 kg of the active ingredient (a.i.) per hectare and at three N levels (0, 22.4 and 44.8 kg of N per hectare). Herbage from fall and from spring-treated plots was harvested four times each year.

In the greenhouse a study was conducted with blue grama plants to determine the effects of low rates of simazine and Bladex on above- and below-ground biomass, on N and P metabolism, and on distribution of these minerals in the plants. Herbicides were soil applied at .28, .56, and 1.12 kg a.i./ha. Herbicide treatments were combined with two levels of N fertilizer, 0 and 97 kg/ha of ammonium nitrate N. The fertilizer was applied when seedlings were 4½ weeks old, 20 days prior to treatment with herbicides. Above- and below-ground biomass was harvested at 5, 20, and 60 days following herbicide application. Dry weight and crude protein content was determined for leaves, stems, and roots. Phosphorus content was determined for all plant parts harvested at 60 days.

As a rule, and particularly at the higher rates, herbicides increased crude protein content and decreased dry matter yield. Simazine reduced root biomass up to 80%. Low rates of Bladex stimulated root and top growth simultaneously.

Atrazine was the most effective and Bladex least effective for increasing crude protein content of herbage.

Bladex accumulated crude protein in roots of blue grama while simazine accumulated protein in the leaf blades. Simazine increased P content, and the increases were greater in top growth than in roots. Bladex had little effect on P content. Nitrogen fertilizer alone decreased P content. Simazine increased P uptake by as much as 245% and N uptake as much as 657%. Nitrogen and P uptake showed a high positive correlation.

Ammonium nitrate fertilizer reduced the effect of the herbicides on plants in the early seedling stage. At later stages herbicide effects were stimulated by additional N. Thus, the type of response appeared to depend on the phenological stage of the plants.

It is suggested that at least two mechanisms are involved in the responses of crude protein content and dry matter yield on shortgrass range herbage and blue grama plants to s-triazines.

Simazine may be a useful chemical for improving forage quality and utilization of grasslands of humid climates. Bladex would be more suited for use on arid and semiarid grassland. Systematic studies of the effects of s-triazines on C3 and C4 plants could provide a better insight in the basic differences between these two groups of plants. They could also make a significant contribution to studies concerning the relationships between carbohydrate and protein synthesis.