treatment in June until November. On an atrazine fallow with no summer weeds, NO$_3$-N increased by 9 lb./acre during the same period. If annual plants utilize most of the available soil moisture before mechanical treatment, or if precipitation after treatment is sparse and soil is dry, nitrification will be suppressed (Alexander, 1965) and NO$_3$-N will not accumulate. For example, after a very dry spring and summer in 1968, NO$_3$-N in the 0- to 6-inch sample on the last sample date at Orovada was 47 lb./acre on the atrazine fallow, about the same as in 1967, compared to only 13 lb./acre on the mechanical fallow.

NO$_3$-N in Soil the Spring After a Fallow Year

At this time of year perennial grasses are in the seedling stage. The amount of NO$_3$-N varied with year, treatment, location, and depth (Table 2). Precipitation during the winter of 1967-68 was 4 to 5 inches at both Trap Butte and Orovada. An average of 31% of the total NO$_3$-N in the surface 24 inches of soil was found in the 0- to 6-inch sample. At Trap Butte on March 20, NO$_3$-N in the 0- to 6-inch sample on the last sample date at Orovada was 47 lb./acre on the atrazine fallow, about the same as in 1967, compared to only 13 lb./acre on the mechanical fallow.

At Orovada on March 20, NO$_3$-N was 8 lb./acre during the same period. If precipitation after treatment is sparse and soil is dry, nitrification will be suppressed (Alexander, 1965) and NO$_3$-N will not accumulate. For example, after a very dry spring and summer in 1968, NO$_3$-N in the 0- to 6-inch sample on the last sample date at Orovada was 47 lb./acre on the atrazine fallow, about the same as in 1967, compared to only 13 lb./acre on the mechanical fallow.

An average of 41% of the total NO$_3$-N in the surface 24 inches of soil was found in the 6- to 12-inch sample. NO$_3$-N in this sample was significantly higher on the atrazine fallow (38 lb./acre) and mechanical fallow (26 lb./acre) than on the check (12 lb./acre).

Samples from 12 to 18 and 18 to 21 inches each contained 14% of the total NO$_3$-N in the surface 24 inches of soil. Average NO$_3$-N in the 12- to 18-inch sample was 10 lb./acre on the atrazine fallow, 9 lb./acre on the mechanical fallow, and 4 lb./acre on the check. Average NO$_3$-N in the 18- to 24-inch sample was 12 lb./acre on the atrazine fallow, 7 lb./acre on the mechanical fallow, and 4 lb./acre on the check.

Precipitation in the Orovada-Trap Butte area from October to the initial spring sample date was 11 to 12 inches in 1968-69, compared to 4 to 5 inches in 1967-68, and to the long term average of 7 to 8 inches. NO$_3$-N data for spring, 1969 reflect this difference in winter precipitation (Table 2). The atrazine fallows at Trap Butte and Orovada contained 45 and 58 lb./acre NO$_3$-N, respectively, in the surface 12 inches of soil in fall, 1968. From 50 to 71% of this NO$_3$-N was leached below 24 inches by spring 1969. Only 9 lb./acre NO$_3$-N were found in the surface 12 inches of the atrazine fallow at each site. At Orovada the 12- to 24-inch sample contained 20 lb./acre NO$_3$-N; at Trap Butte only 4 lb./acre NO$_3$-N were found.

As in 1968, NO$_3$-N accumulated in the 0- to 3-inch depth on treated plots during spring, 1969. Average levels at seven locations were: April 28—fallow 5 lb./acre, check 2 lb./acre; May 12—fallow 12 lb./acre, check 1 lb./acre; and June 9—fallow 10 lb./acre, check 2 lb./acre.

**Literature Cited**


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**Vegetation and Soils of Two Southern High Plains Range Sites**

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**Highlight**

Soil and vegetational properties associated with a high lime and a mixed plains site on the Texas High Plains were analyzed. Density of grass cover was similar on both sites, but the high lime site supported a higher percentage of climax grasses. Mesquite trees were dense on the mixed plains site, but virtually absent from the high lime site. The high lime site was characterized by a gravelly, strongly alkaline soil high in clay content and low in bulk density; the mixed plains site had a brownish, moderately alkaline soil high in sand content and high in bulk density. Phosphorus, sodium, pH, and organic matter were higher in the high lime soils.

Distinct plant communities occur throughout the southern High Plains of Texas on areas of similar climate and topography. The narrow ecotones between them suggest that edaphic factors may be controlling their floristic composition and productivity.
The absence of mesquite (*Prosopis glandulosa* var. *glandulosa* (Benson) Johnson) from some sites while other sites receiving the same grazing treatments and rainfall supported dense stands of the woody species attracted our interest.

This study was designed to evaluate the vegetative resources of two range sites on the southern High Plains and to isolate factors that contribute to the plant distribution and abundance. These contrasting range sites were: 1) a mixed plains site with dense mesquite growth and 2) a high lime site with no mesquite on it.

These adjacent sites were in the same pasture on the Post-Montgomery Ranch about 25 miles southeast of Tahoka, Lynn County, Texas. The study area is located in the southern portion of the mixed prairie (Weaver and Albertson, 1956). The elevation is 3,100 ft. Average annual rainfall is slightly less than 20 inches (19.4 inches at Tahoka).

The soils of the study area formed from calcareous, unconsolidated outwash materials from the Rocky Mountains (Evans and Meade, 1945). The soils of the mixed plains sites are Mollisols mainly of the Portales and Mansker series. The predominant soils of the high lime site are Aridisols with the Arch series being the most common one (Soil Survey Staff 1959, 1960).

**Methods and Procedures**

Twenty sampling locations were selected at random on each of the two sites within pastures that had received similar grazing treatments for many decades on the Post-Montgomery Ranch. The area was grazed continuously in a single pasture prior to 1962. After that time, the study area has been part of a four pasture deferred rotation system with a stocking rate of 1 animal unit per 40 acres. Species composition, basal density of grasses and mesquite canopy cover were measured at each of the 20 locations on each site by use of a 100 ft line intercept similar to that described by Canfield (1942). Range condition, as estimated by the percent of climax plants, was determined at each sampling location in each range site. Density of woody vegetation was measured by the point centered quarter method of Cottam and Curtis (1956) using the west end of each vegetation intercept as a random point.

Composite samples were made from soil auger cores, from depths of 0 to 6 inches, 15 to 26 inches, and 26 to 30 inches respectively to correspond with the A, B, C soil horizons on each site. The composite soil sample was taken along each of the 20 vegetational transects and analyzed for soil pH, available calcium, available sodium, and total salts. Differences between variables on each site were determined by Students T-test; correlation coefficients were computed between variables on each site using standard statistical procedures (Steel and Torrie, 1960).

**Results and Discussions**

Soil and vegetational properties associated with the two sites were significantly different. These differences were of sufficient magnitude to alter management practices for each site, justifying the retention of each site as an ecological entity. Soil-plant relationships were different on each site (Table 1).

<table>
<thead>
<tr>
<th>Vegetation</th>
<th>Mixed plains</th>
<th>High lime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range condition</td>
<td>39.2</td>
<td>86.4**</td>
</tr>
<tr>
<td>% grass cover</td>
<td>50.1</td>
<td>51.4</td>
</tr>
<tr>
<td>% mesquite cover</td>
<td>37.0**</td>
<td>0.0</td>
</tr>
<tr>
<td>Mesquite/acre</td>
<td>268.7**</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Significantly greater at 0.01 probability level.**

Absence of observable mesquite from the high lime site was the most outstanding vegetational difference between the two communities. In contrast to the absence of adult mesquite on the high lime site, the mixed plains site had an average canopy cover of 37% and 268.7 mesquite plants per acre (Table 1).

A few mesquite seedlings were found on the high lime site, but they were so scarce as not to be encountered by the sampling method used. Only after careful search of the area were seedlings found. None survived and grew into trees during the study.

There was no difference between the total grass cover on the two sites. The high lime sites supported a significantly higher percentage of climax plants contrasted to a preponderance of increaser plants on the mixed plains site.

The most abundant plants on the high lime site were blue grama (*Bouteloua gracilis* (Willd.) (ex. H.B.K.) lag. ex Griffiths), sideoats grama (*Bouteloua curtipendula* (Michx.) (Torr.) and vine mesquite (*Panicum obtusum* H.B.K.). Forbs were scarce at the time of the late summer field survey. The most common broadleaf plant was one seeded Croton (*Croton monanthogynus* Michx.). Woody plants were lacking. Few scattered plants of plains prickly pear (*Opuntia polyacantha* var. *trichophora* (Engelm. and Bigel) Coult.) were scattered over the area (Table 2).
The major species on the mixed plains sites were buffalo-grass (*Buchloe dactyloides* (Nutt.) Engelm.), blue grama, and tobosa grass (*Hilaria mutica* (Buckl.) Benth.). This site has significantly more buffalograss, tobosa grass, and mesquite than the high lime site.

The mixed plains site had significantly more blue grama, sideoats grama, vine mesquite, Halls panic (*Panicum hallii* Vasey) and sand muhley (*Muhlenbergia arenicola* Buckl.). Occurrence of mesquite did not alter total grass cover, but was associated with a decrease in climax plants. Increases in both the number of plants per acre and the density of mesquite cover was associated with a significant reduction in climax grasses (Table 2). A negative relationship existed between mesquite composition and grass cover, but this relationship was not significant.

The physical soil properties of the two sites were different. The high lime site was characterized by a grayish, strongly alkaline soil, high in clay content and low in bulk density. The clay fraction of the high lime soil was significantly higher than for soils on the mixed plains site. There was no difference in the silt fraction. The soils of high lime sites were significantly lower in sand and bulk density. The mixed plains site was characterized by a brownish, moderately alkaline soil high in sand content and high in bulk density (Table 3).

Chemical factors of the soil were different for each community. The high lime site was significantly higher in pH, phosphorous, potassium at the 26 to 36 inch level. Sodium and organic matter below 15 inches was also significantly higher on the high lime site. Potassium in the upper 6 inches was significantly higher in the mixed plains site (Table 4).

Infiltration rates of over 7 inches per hour were obtained for the high lime site. These rates are significantly greater than the 3.34 inches per hour for the mixed plains site (Table 5). The highest infiltration rates were obtained on the site highest in clay content. Sandier soils generally are

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### Table 2. Comparison of basal density of herbaceous and woody vegetation on two range sites on the Southern Great Plains.

<table>
<thead>
<tr>
<th>Species</th>
<th>Composition (%)</th>
<th>High lime site</th>
<th>Mixed plains site</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Bouteloua gracilis</em></td>
<td>56.1**</td>
<td>15.7</td>
<td></td>
</tr>
<tr>
<td><em>Bouteloua curtipendula</em></td>
<td>11.9**</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td><em>Panicum obtusum</em></td>
<td>12.4*</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td><em>Buchloe dactyloides</em></td>
<td>5.8</td>
<td>60.7**</td>
<td></td>
</tr>
<tr>
<td><em>Sporobolus cryptandrus</em></td>
<td>4.1</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td><em>Panicum hallii</em></td>
<td>3.6**</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td><em>Muhlenbergia arenicola</em></td>
<td>3.0**</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td><em>Aristida wrightii</em></td>
<td>0.9</td>
<td>2.8*</td>
<td></td>
</tr>
<tr>
<td><em>Hilaria mutica</em></td>
<td>-</td>
<td>7.4**</td>
<td></td>
</tr>
</tbody>
</table>

* *Significantly greater at 0.05 probability level.

** *Significantly greater at 0.01 probability level.

### Table 3. Average values of soil physical properties on range sites on the southern High Plains.

<table>
<thead>
<tr>
<th></th>
<th>Depth (inches)</th>
<th>High lime site</th>
<th>Mixed plains site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand (%)</td>
<td>0–6</td>
<td>33.32</td>
<td>52.77**</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>0–6</td>
<td>26.25</td>
<td>25.68</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>0–6</td>
<td>40.48**</td>
<td>21.55</td>
</tr>
<tr>
<td>Bulk density 0–4</td>
<td>1.09</td>
<td>1.32**</td>
<td></td>
</tr>
<tr>
<td>Bulk density 6–10</td>
<td>1.09</td>
<td>1.31**</td>
<td></td>
</tr>
</tbody>
</table>

** *Significantly greater at 0.01 probability level.

### Table 4. Average values for chemical analyses at 20 locations on each of two range sites on the southern Mixed Prairie1.

<table>
<thead>
<tr>
<th></th>
<th>pH2 (lb./acre)</th>
<th>Po3 (lb./acre)</th>
<th>K3 (lb./acre)</th>
<th>Ca4 (lb./acre)</th>
<th>Na5 (lb./acre)</th>
<th>Salt6</th>
<th>Organic7 matter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High lime site</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 6 inches</td>
<td>8.4**</td>
<td>81.1**</td>
<td>566</td>
<td>6000+</td>
<td>951**</td>
<td>none</td>
<td>1.68</td>
</tr>
<tr>
<td>15 – 26 inches</td>
<td>8.4**</td>
<td>65.2**</td>
<td>450</td>
<td>6000+</td>
<td>1253**</td>
<td>none</td>
<td>1.23**</td>
</tr>
<tr>
<td>26 – 36 inches</td>
<td>8.5**</td>
<td>63.5**</td>
<td>580**</td>
<td>6000+</td>
<td>1499**</td>
<td>none</td>
<td>0.99**</td>
</tr>
<tr>
<td><strong>Mixed plains site</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 6 inches</td>
<td>8.2</td>
<td>36.1</td>
<td>749</td>
<td>6000+</td>
<td>375</td>
<td>none</td>
<td>1.54</td>
</tr>
<tr>
<td>15 – 26 inches</td>
<td>8.2</td>
<td>29.5</td>
<td>465</td>
<td>6000+</td>
<td>577</td>
<td>none</td>
<td>0.94</td>
</tr>
<tr>
<td>26 – 36 inches</td>
<td>8.2</td>
<td>35.0</td>
<td>380</td>
<td>6000+</td>
<td>856</td>
<td>none</td>
<td>0.75</td>
</tr>
</tbody>
</table>

1 *Analyses determined by International Minerals Soil Test Laboratory.
2 *Readings made from 1:2 water extract with Beckman pH meter.
3 *Determinations made from an ammonium acetate extract buffered to pH 4.2.
4 *Readings from Solu-Bridge tester from 1:2 water extract; reported as salinity hazard.
5 *Determined by the Walkley-Black procedure.
6 ** *Significant differences between sites at 0.01 probability level.
expected to receive water faster than those with finer particles. However, the mixed plain site, characterized by sandy loam texture, showed less favorable soil aggregation and moisture relationships when compared to the soils of the high lime site. The percent moisture held at field capacity and at permanent wilting percentage was not significantly different between the two sites. However, the available moisture on the high lime site was significantly greater than for the mixed plains site.

The high lime site was in better range condition than the mixed plains site. Infiltration studies conducted by Dee, Box, and Robertson (1966) indicated that intake rates increased as range condition progressed toward the climax on Pullman Silty Clay Loam. The lower infiltration rate on the mixed site may be due simply to degradation of the vegetative cover and subsequent degradation of soil aggregation on the mixed plains site.

Relationships Between Vegetational and Soil Properties

Correlation coefficients were computed between all variables measured using the procedure outlined by Box (1961) for each site. The total amount of grass cover was not related to any soil attribute except organic matter in the upper level on either site. Some soil attributes and plant composition were related on each site, but these relationships were different for the two sites.

Mixed Plains Site

Grass cover and soil organic matter were positively correlated \((P < 0.05)\) in the upper 6 inches of soil on the mixed plains site. This relationship is to be expected since much of a grass plant’s production is fibrous roots. These roots are generally concentrated in the upper levels in semi-arid climates.

Infiltration rates increased as range condition improved \((P < 0.01)\). In contrast, infiltration rates decreased as mesquite attributes increased, though the relationship was not statistically significant. This relationship related to Paulsen’s work of 1953. He found that soil under mesquite had less favorable soil structure and moisture relations than that under perennial grass.

In our study the larger amounts of mesquite canopy occurred on soils that were lowest in pH, organic matter, and highest in potassium at the lower levels.

High Lime Site

No significant relationships existed between grass cover and soil properties on the high lime site. Range condition on the high lime site increased with phosphorous content of the soil and clay content in the upper 6 inches. Organic matter and phosphorous, and potassium contents of the soil 15 to 26 inch level were positively related to range condition. Range condition was negatively associated with the sand content of the soil and bulk density in the upper 6 inches.

In general, climax plants were found abundantly on those transects highest in organic matter, phosphorous, and potassium. Little association was observed between decreaser plants and soil reaction or sodium content. The better range plants were associated with soils of higher clay contents and low bulk densities.

Literature Cited


