

THE EFFECT OF FERTILIZERS ON FORAGE AND SEED PRODUCTION, DORMANCY OF  
FRESHLY HARVESTED SEED AND CHEMICAL COMPOSITION OF STOVER OF  
CADDO SWITCHGRASS (PANICUM VIRGATUM, L.) AND  
CORONADO SIDE-OATS GRAMA GRASS (BOUTELOUA  
CURTIPENDULA, (MICHX.) TORR.)

By

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## INTRODUCTION

It has been estimated that over twelve million acres in the Southern Great Plains are not suited for cultivation and need to be seeded to permanent grass cover (18)<sup>/1</sup>. Additional millions of acres are to be established to perennial grasses for an indefinite period of time to adjust crop acreages. All federally sponsored programs dealing with range and pasture reseeding or reclamation work should utilize the available adapted sources of improved grasses.

In the past, the grass seed supply has been dependent upon the wild harvest of seed from our native ranges and pastures during favorable years. This source of grass seed is not reliable, and usually the seed harvested is of very low quality.

Only through the grass seed grower's ability to produce seed can the maximum utilization of improved grasses be obtained. More efficient methods are needed for grass seed production to fill the critical shortage. This study investigates some of the problems associated with seed production of two native grasses in Oklahoma.

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<sup>/1</sup> Numbers in parentheses refer to Literature Cited

## REVIEW OF LITERATURE

Fertility studies conducted on side-oats grama grass by Hamilton and Wooten (16) in Arizona showed that if side-oats grama was over-fertilized with nitrogen prior to the flush of growth in July, the plants would lodge. They stated that side-oats should be managed in such a way as to produce a thrifty plant ready to put up its seed heads when this flush of growth occurs. Too little is known of the possibility of reducing lodging with adequate amounts of phosphorus and potassium. No fertilizer recommendations were made by these authors for side-oats grama, but fertility rates recommended for other grasses, such as weeping lovegrass, Wilman lovegrass, sand lovegrass, smilo, rescue grass, and wheatgrass, varied from 60 to 100 pounds of nitrogen per acre.

In Nebraska, Jackson (22) concluded that thirty pounds of nitrogen per acre was the most effective rate for seed production of side-oats grama. He reported there was no advantage obtained from the application of phosphate either alone or in combination with nitrogen in relation to seed yield.

Harlan and Kneebone (17), using a split rate of fertilizer treatments on switchgrass, found that forty pounds of nitrogen per acre applied in early spring plus thirty pounds at boot stage gave significant increase in seed yields. However, no significant differences were obtained when comparisons were made between the forty-thirty pound split rate applied in early spring and at boot stage respectively and a seventy-thirty split rate or a one hundred pound rate applied once in early spring, in number

of panicles produced per plot, nor in the grams of seed produced per fertilized plot.

In a similar study conducted in Oklahoma, Kneebone (24) applied 50 pounds of nitrogen per acre to blue grama grass planted in 12 inch rows in mid-August and obtained a highly significant increase in seed yields. Adequate irrigation water was applied after fertilization and was continued until the seed had reached the soft dough stage.

As a general rule, Smith (35) stated, our native grasses yield six to ten times more seed under cultivation as compared to wild harvest. Grasses that produce seed in the fall will respond best to applications of just enough water throughout the season to maintain good heavy growth, followed by heavy applications of water about six weeks before maturity. In addition he reported that grasses producing seed crops early in the summer benefit from forty to fifty pounds of actual nitrogen per acre. The need becomes apparent about the third seed crop under dryland conditions, and the second crop under irrigated conditions.

Broadcast applications of ammonium nitrate on little bluestem in Oklahoma will increase seed stalk production according to Murphy and others (32). Nitrogen application in combination with phosphorus produced the greatest number of seed stalks. Murphy stated that light applications of nitrogen are not sufficient for maximum seed yields, and superphosphate alone may actually decrease the seed stalk yield. With studies conducted on weeping lovegrass planted in three foot rows, at seven locations, these workers concluded that phosphorus alone does not increase seed yield. They reported nitrogen applications of 45 to 48 pounds per acre produced from each pound of nitrogen applied .91 to 4.76 pounds of weeping lovegrass seed.

Cook and Parmer (13), measuring forage yields of six varieties of side-oats grama planted in rows and fertilized with 60-60-0 under dry-land conditions in Texas ranked Coronado third highest in production. The varieties were clipped twice with Coronado yielding a total of 1,825 pounds of oven-dry forage per acre.

In a study of brome grass seed production in New York, Cain and others (9) observed that nitrogen applications on very fertile soil caused lodging; whereas, on fields of moderately fertile soils, he recommended rates of 200 to 300 pounds of 10-10-10 to be applied in the fall; spring applications should be avoided to prevent lodging. He reported seed yields as high as 1,100 pounds per acre were produced in three foot cultivated rows.

In Kansas, Anderson and others (1) increased brome grass seed yields ninety-nine percent over check plots on old established stands with a two-hundred pound rate of ammonium sulfate per acre. On new stands a heavier rate of four-hundred pounds per acre was needed to increase seed yields forty percent over that produced by the check plots. The addition of phosphate had no effect on yield of forage or seed.

Churchill (11) pointed out that fertilized plots of brome grass were likely to produce less seed the year following fertilization than if left unfertilized. He found, also, that an eighty pound rate of nitrogen per acre on broadcast stands was the most practical application for increasing seed yields in Michigan.

A rate and time of application study of ammonium sulfate on brome grass conducted by Harrison and Crawford (20) showed that 100, 250, and 500 pound rates applied in May favored seed yields and that 750 and 1000 pound rates applied at this time favored forage yields.

In an investigation of cultural practices which favor maximum seed production of orchard, brome, timothy and Reed canary grass, Buller (3) found that 100 pounds of nitrogen per acre significantly increased seed yields in canary grass, whereas a 200 pound rate produced the best seed yields in both brome and orchardgrass, while a 50 pound rate gave the best response for seed yields on timothy. Significantly higher seed yields were produced on the grasses seeded in rows than in broadcast stands.

On irrigated land in Idaho, Oman and Stark (33) reported that 55 pounds of nitrogen per acre on mountain brome grass produced an increase of three pounds of seed for every pound of nitrogen applied. In another study with tall oatgrass, smooth brome grass and orchardgrass grown in rows three feet apart, 60 pound rates of nitrogen per acre produced seed increases of 55% over the yield produced by the check plots.

With applications as high as 1,250 pounds per acre of nitrate of soda (equivalent to 200 pounds of nitrogen) on orchardgrass, Jones and others (23) found that seed yields increased with nitrogen added up to and including 100 pounds per acre. Plant tissue tests showed that orchardgrass fertilized with 150 to 200 pounds of actual nitrogen per acre carried a very high percentage of soluble nitrogen and generally a low percentage of potassium. They stated that this condition favors lodging when high rates of nitrogen are used.

In a study as to the effect on orchardgrass seed yield of different sources of nitrogen, MacVicar and Gibson (29), using five different nitrogen fertilizers, found that the form of nitrogen was not very important. Eighty pounds per acre of ammonium sulfate gave a significant increase in seed yields as did the 20 and 160 pound rates of calcium cyanamide.

They reported no additional response in seed yields from an application of 160 or 320 pounds of nitrogen per acre when compared to the 80 pound rate. A significant difference was also found, however, in the weight in grams per 1000 seeds from the different treatments. Seed produced on the fertilized plots receiving 40 pounds of nitrogen per acre and over had higher gram weight average than the check and 20 pound rate.

Lodging in Kentucky 31 fescue and orchardgrass was found by Spencer (36) to be a problem with heavy rates of nitrogen. In addition, the lodging problem increased progressively with late application dates. Spencer observed that burning and an application of nitrogen gave a significant increase in forage and seed production by both fescue and orchardgrass.

The influence of burning and fertilization on seed production in some southern grasses was studied by Burton (4). He found that fertilization of burned plots gave the greatest seed yields, but the percentage increase due to fertilization was greater in the unburned plots. He concluded that burning had no significant effect upon seed yields, and that nitrogen alone will produce as much seed as an equivalent amount of nitrogen applied in a 4-8-4 fertilizer.

In Canada, Knowles (26) working with crested wheatgrass, obtained significantly greater seed yields with fall fertilizer applications than when treated in the spring. Seed yields of 428 pounds per acre were obtained with 264 pounds of ammonium nitrate applied in the fall compared to 112 pounds of seed produced with spring applications of 112 pounds of fertilizer. He found that ammonium phosphate was more effective when applied in the fall than in spring. Knowles recommended the use of fertilizers high in nitrogen such as ammonium nitrate or ammonium

sulfate on old stands. Rates of 75 to 150 pounds per acre of ammonium nitrate or 100 to 200 pounds per acre of ammonium sulfate applied in the fall were recommended for seed production on crested wheatgrass.

Under dryland conditions in Idaho, Klages and Stark (25) found that 20 pounds of nitrogen per acre (100 pounds of ammonium sulfate or 60 pounds of ammonium nitrate) was usually sufficient for grass seed production. In areas where 20 or more inches of rain fall, 50 pounds of nitrogen per acre can be used. They reported as much as 90 pounds per acre could be used to advantage in the irrigated parts of the state.

Letting seed head counts serve as an index of the influence of fertilizer treatment upon seed yields, Burton (5) found in a number of southern grasses studied that the application of phosphorus and potassium without nitrogen significantly increased the number of heads in only common bermuda. The addition of nitrogen to the basic phosphorus and potassium treatments materially increased the production of seed heads in most of the grasses studied.

In a study of row-spacing, depths and rates of seeding for production of grass seed, McWilliams (31) concluded that, in general, 30 inch rows were the best for grass seed production. After the stand was three years old, the 18 inch rows dropped in production while the 30 to 42 inch spacings continued to produce satisfactorily.

Nitrogen fertilization did not give seed increases of Russian wildrye during the application year, according to studies conducted by Stitt (37). However, the response was apparent the following year. He reported row spacings of 1.5 to 2 feet apart, with applications of 100 and 200 pounds of nitrogen per acre gave the highest seed yields under irrigation.

Defrance and Odland (14) found that seed yields of velvet bentgrass could be increased by moderate applications of nitrogen. They found phosphorus and potassium had little effect upon seed yields either alone or with nitrogen.

Working with ryegrass in New Zealand, Chrystall (10) obtained seed yields ranging from 43 to 60 bushels when grown with clover as a companion crop.

For production of Rhodesgrass seed Lancaster (27) recommended 200 pounds per acre of ammonium nitrate and 500 pounds of 0-14-7 for maximum yields.

Fertilizer placement tests conducted by Riewe and Smith (34) on an improved perennial pasture consisting of Dallis grass, bermuda grass, and white clover, using 40, 80, 160, and 320 pounds per acre of  $P_2O_5$  with and without 50 pounds of nitrogen, applied 10 and 20 inches apart in bands below the surface and broadcast, showed potash and phosphate had no influence on forage yields. Also, more weeds were observed where fertilizer was banded beneath the soil. In another study radioactive phosphate was used to measure the efficiency of phosphate broadcast on the surface in comparison with phosphate banded below the surface. Likewise, the application of nitrogen increased the amount of fertilizer phosphorus removed in the forage. The method of fertilizer placement did not affect forage yields, but they were significantly increased by nitrogen and phosphorus applications.

A number of grasses were studied by Fudge and Fraps (15) to determine the effect of various fertilizers upon the yield of forage. Sodium nitrate increased the yield of forage by 17% when compared to a check, but did not significantly change the chemical composition. Ammonium

sulfate and muriate of potash had no significant effect upon either yield or chemical composition of the grasses studied. They found that lime phosphate increased the yield of forage by 45%, and calcium in the forage by 18% but had no significant effect upon percentage of protein or phosphorus. Superphosphate applied on unlimed plots more than doubled the yield of forage, while it increased the percentage of protein and calcium by about one-third and the percent  $P_2O_5$  by one-half. Differences in the protein and phosphorus content of the grasses studied at the mature stage from different groups of soils were very small.

Brown (8) studied the chemical composition of pasture species of the northeast region as influenced by fertilizers. In timothy nitrogen content of forage increased as the amount of nitrogen fertilizer applied increased. Heavier rates of nitrogen (56 pounds per acre) lowered the value of potassium in the forage. Brown stated that this indicated a lack of proper balance in the supply of nutrients. In Kentucky bluegrass and Rhode Island bentgrass the source of nitrogen had a profound effect on the percent nitrogen in the dry matter. Source of nitrogen also had an effect on the content of phosphorus in the dry matter. Calcium uptake was also effected. Fertilizers carrying sodium increased the potassium content in the grasses, while magnesium fertilizers had the opposite effect. The use of physiologically neutral or alkaline nitrogen carriers resulted in higher nitrogen, phosphorus and calcium contents in the grasses studied.

Brooks and Holt (6) reported average forage yields of 3 to 4 tons per acre were produced annually under irrigation by the better species of grass in a warm season grass yield test at Iowa Park, Texas. The five highest yielding grasses were coastal bermuda, blue panic, Johnsongrass, King

Ranch bluestem, and Blackwell switchgrass. Blackwell switchgrass ranked fourth and fifth for the two years, yielding close to 4000 pounds per acre annually. Forage yields in excess of 13 tons of air-dry forage per acre were produced with coastal bermudagrass at Crystal City, Texas, with 200 pounds of nitrogen applied per acre, and at College Station with 1000 pounds of nitrogen.

When protected to the end of the season, Lang and Barnes (28) found, side-oats grama and buffalograss yielded more forage than when harvested frequently. Mid-season grasses, western wheatgrass, sanberg bluegrass, and slender wheatgrass produced more forage when cut only once.

In Florida, Blaser and others (2) found more forage was produced by napiergrass if split applications of 32 pounds of actual nitrogen were applied in March and June.

A frequency of clipping study on Russian wildrye conducted by Thaine (39) in Canada showed greater yields were obtained from taking 2 to 3 cuttings per season than from only 1 or 2 cuttings.

Tests were conducted on tall oatgrass and alta fescue under irrigation in Montana. Forage yields were doubled by Stitt (38) with an application of 100 pounds of nitrogen per acre as compared to a check.

Many variables influence yield in grasses of both seed and forage. Brown (7) observed that Kentucky bluegrass, Canada bluegrass, and orchardgrass made some growth at 40° F; whereas bermudagrass made no growth and very little at 50° F. The optimum temperature for top growth was 80° to 90° F for Kentucky bluegrass and Canada bluegrass, 70° F for orchardgrass, while the maximum top growth for bermudagrass was obtained at 100° F.

Harrison (19) observed Kentucky bluegrass made little growth at 100° F in sand culture, however, the addition of nitrogen stimulated the yields at 80° F.

Seed dormancy and germination in native grasses are important factors in establishment. Conkos (12), studying seed dormancy in some native grasses in Illinois, showed that side-oats grama was more sensitive to storage temperatures than seeds of other species in the test. Cold storage prolonged dormancy to 14 months, whereas, dormancy broke in 2 to 6 months under room temperature.

The effect of maturity at time of harvest in crested wheatgrass was studied by Hermann and Hermann (21). They reported that storage was necessary for good seed germination after harvest, and that the germination after storage was higher as maturity increased. McAlister (30) obtained similar results in his study on some of the western range grasses.

## METHODS AND MATERIALS

Seed production studies on Coronado side-oats grama, Bouteloua curtipendula, Michx., Torr and Caddo switchgrass, Panicum virgatum L., were conducted under irrigated and dryland conditions at the El Reno Livestock Research Station.

Both grasses were established in cultivated rows three feet apart on a Brewer clay loam soil, high in available phosphate and potassium, medium to high in nitrogen and with a pH of 7.5, (Table III). The Coronado side-oats grama was established in the spring of 1953, and Caddo switchgrass was established in the spring of 1955.

A furrow type surface irrigation system was used in the application of water. As shown in Table II, a total of 37 inches of supplemental water was applied to side-oats grama in 1956; whereas, in 1957 no irrigation water was needed for the first seed crop and only 19 inches was applied to produce the second crop. Switchgrass received 32 inches of supplemental water in 1956, and 17 inches in 1957.

The area selected for study on each grass was chosen for uniformity of stand and soil. Forty-eight plots, each consisting of three rows, three feet apart and twenty feet long, with border rows along the outside and a five foot unfertilized area on the ends, were used for each grass and field condition.

Twelve rates of fertilizers were used in a completely randomized block design, with four replications of each treatment. Broadcast applications of fertilizer were made by hand.

Rates of fertilizers and design used were the same for both grasses under both conditions.

Fertilizer rates in pounds of nitrogen, phosphorus ( $P_2O_5$ ) and potassium ( $K_2O$ ) respectively were as follows:

0-0-0, 0-0-100, 0-100-0, 0-100-100  
 100-0-0, 100-0-100, 100-100-0, 100-100-100  
 200-0-0, 200-0-100, 200-100-0, 200-100-100

The commercial fertilizers used to obtain these rates were ammonium nitrate (33% N), muriate of potash (60%  $K_2O$ ), and treble superphosphate (46%  $P_2O_5$ ).

After the year of establishment, Coronado side-oats grama will produce two seed crops under irrigation, and one or sometimes two in good years under dryland conditions. The first crop is usually harvested in June and the second in September.

On June 21, 1956, fertilizer treatments were applied on side-oats grama after the first seed crop was removed. In 1957, fertilizer was applied April 21 and July 27 on both irrigated crops. The side-oats grama plots grown on dry land received an application of fertilizer on June 21, 1956, and April 21, 1957.

The switchgrass plots established in 36 inch rows in the spring of 1955 were fertilized June 21, 1956, on both the irrigated and dryland plots, just prior to boot stage and on April 21, 1957, prior to the heavy early spring growth.

In 1956 the second crop of Coronado side-oats grama produced on both dry and irrigated fields was harvested October 24. The first seed crop in 1957 of Coronado side-oats grama was harvested from both land conditions July 2. The second seed crop obtained on the irrigated field was harvested October 10, 1957.

Both forage and seed yields were taken on switchgrass September 8 under irrigation and September 16 on dryland, in 1956. In 1957 harvest dates were September 3 under irrigation and August 26 on dryland.

The seed crops of both grasses were harvested by topping the seed heads in each plot by hand in 1956 with a sickle. The heads were then placed in a sack, labeled, dried and threshed with a Vogel nursery thresher. The threshed seed was scalped, lightly hammer-milled and cleaned with a small clipper cleaner before the weight was recorded.

Forage yields in 1956 were taken on both grasses by mowing the entire plot after seed crop removal. A sample was taken from each plot for chemical analyses and dry matter determination. All chemical analyses were made by the Department of Biochemistry.

Because of the time involved in handling, the method of harvesting both seed and forage yields of both grasses was changed in 1957. One row, twenty feet long in each plot was selected at random and harvested by hand for seed yields. Forage yields were taken by mowing the topped row in side-oats and by mowing one of the two remaining 20 foot rows of switchgrass.

Prior to harvesting seed yields in 1957, small samples of side-oats grama seed were hand-stripped from each fertilized plot in both the dryland and irrigated areas. Each sample was thoroughly mixed and divided to an approximate five gram sample, weighed, and the caryopses were extracted from the appendages, and the percent of naked seed was determined for each plot.

The extracted seeds were used in the germination study to measure the effect of fertilizer on the dormancy in freshly harvested seed. Each caryopsis used was selected as a perfect seed, cracked, broken and shriveled seed being rejected. Four samples of one-hundred seeds each were

selected at random from the perfect seed fraction of both grasses to represent the harvest from each fertility treatment on dryland or irrigated plots. One sample (replication) from each fertility treatment was placed at random on each of four trays which, in turn, were randomly placed in the germinator.

Germination tests were conducted as prescribed by A.O.S.A. (Association of Official Seed Analysts) with the exception that naked caryopses of side-oats grama were germinated from each level of fertilizer treatment. According to the official method, seeds for germination shall be taken from the separation of the kind or variety considered pure seed and shall be counted without discrimination as to size or appearance. The pure seed fraction in native grasses includes the enclosure around the caryopses as well as the group or clusters which may have more than one grain present, but is counted only as one.

Switchgrass seed was taken in a similar manner from each fertilized plot, as was side-oats grama, except the caryopses were not extracted from the lemma and palea. The seed was cleaned and separated into a pure seed fraction, which was used in the germination study.

Germination tests were repeated in the same manner at intervals until dormancy was broken.

A Shultz Da-Lite germinator equipped with a thermograph set for an alternating temperature of 20° C for 16 hours of darkness and 30° C for an eight hour light period was used in this study. Counts were made at seven day intervals for a 28 day period.

## RESULTS AND DISCUSSION

The fertilization of Caddo switchgrass prior to early boot stage in 1956 or from an early spring application in 1957 (Table I) had no significant effect on yield of seed or stover produced in either year under dryland or irrigated conditions. However, the average total seed yields produced under irrigation for the two year period were five to nine times greater per acre than the yields obtained on dryland. Stover yields produced under irrigation in comparison to dryland were 2.5 tons greater per acre.

Non-fertilized plots, as well as fertilized plots, lodged under irrigation during both years. Dryland switchgrass did not mature in 1956 due to the lack of moisture, and lodging was not noted. The more favorable rainfall during the growing season in 1957 (Table II) allowed switchgrass on dryland to mature and set seed. All plots that received nitrogen as part of their fertility treatment lodged under dryland conditions in 1957.

A negative correlation between forage and seed yields was obtained in 1956, and a positive correlation was obtained in 1957. This emphasizes that it is not enough simply to supply adequate amounts of water and fertilizer for good vegetative growth, as good seed yields do not always accompany good forage yields.

Temperature conditions prevailing during the blooming period in August, 1956 were very high. There were 15 days of recorded mid-afternoon temperatures of 100° F and over. This condition was followed by hot dry winds which caused considerable blasting of seed heads in switchgrass and



Figure 1. Dryland plots of Caddo switchgrass,  
June 6, 1957.



Figure 2. Irrigated plots of Caddo switchgrass,  
June 6, 1957.

a reduction in yield of seed. A more favorable temperature condition prevailed during the bloom and dough stages in 1957. Yield of seed produced per acre was considerably higher in 1957 than in 1956. It is the author's opinion that response in seed yield due to fertilization cannot be measured except in optimum years unless temperature and other variables, other than water and fertilizer, affecting seed set in switchgrass can be controlled.

The soil fertility level (Table III) at the start of this study was sufficient to meet the nutrient needs of switchgrass under both land conditions, for the two year period. In comparing the chemical composition of stover obtained from the check plots with the chemical composition of the stover harvested from the fertilized plots (Table IV), switchgrass utilized very little of the applied nitrogen, phosphorus and potassium. The chemical composition was not notably changed due to fertilizer application on either dry or irrigated land for the two years of study. The protein and phosphorus content of the stover produced on dryland was consistently higher than the stover produced under irrigation. The protein content of the irrigated stover harvested from the check plots in 1956 compared to the protein content in 1957, indicates that the level of available soil nitrogen may be lowering. If this study had been started on the soil three years after the establishment of switchgrass instead of one year, positive responses on seed and forage yields due to fertilization may have been obtained.

Switchgrass grown under dryland conditions (Figure 1) matures earlier than when grown under irrigation (Figure 2). At the time of harvest of the dryland seed crop, August 26, 1957, the crop was fully matured and in a dead ripe stage. Some loss was noted due to shattering. The seed harvested September 7, 1957, under irrigated conditions was not fully ripened,

and no loss due to shattering was noted. The germination of the fresh seed (Table V) harvested from each fertilized plot on both irrigated and dryland in 1957 suggests that fertilization with nitrogen and phosphorus may have a favorable effect on germination of freshly harvested mature seed. The seed produced under irrigation is less dormant than seed grown under dryland conditions, and the stage of maturity at the time of harvest may have an effect on the length of dormancy involved in freshly harvested switchgrass seed. Under dryland conditions seed harvested from plots which received the 100 pound nitrogen rate and the 100 pound phosphorus rate had a significantly greater average percent germination and less dormant seed at each germination interval of one month, three months, and seven months after harvest than seed produced from other treatments. Seed harvested from each fertility treatment under irrigation, although significant differences were measured at one and three month intervals, did not show any consistency in germination as to any particular fertilizer rate; no difference in germination could be measured as to the effect of fertilizer at the seven month interval.

TABLE I

MEAN YIELD IN POUNDS OF SWITCHGRASS SEED AND STOVER PRODUCED PER ACRE PER TREATMENT  
UNDER IRRIGATION AND DRYLAND IN 1956 AND 1957.

Treatment	Seed Yields (Pounds Per Acre)						Stover Yields (Pounds Per Acre)					
	Irrigated			Dryland			Irrigated			Dryland		
	1956	1957	2 Yr. Total	1956	1957	2 Yr. Total	1956	1957	2 Yr. Total	1956	1957	2 Yr. Total
0-0-0	384	582	966	--	207	207	8149	6991	15140	3846	5755	9601
0-100-0	376	631	1007	--	288	288	8493	6881	15374	4911	6003	10914
0-0-100	452	638	1090	--	127	127	8703	7555	16258	5449	5577	11026
0-100-100	451	535	986	--	192	192	8569	7114	15683	4557	5787	10344
100-0-0	454	694	1148	--	232	232	7317	7187	14504	4207	5642	9849
100-100-0	555	633	1188	--	158	158	8783	7069	15752	4734	6258	10992
100-0-100	374	592	966	--	175	175	8581	7639	16220	4087	6457	10544
100-100-100	481	575	1056	--	168	168	8297	6989	15286	3525	5671	9196
200-0-0	380	558	938	--	133	133	8742	7218	15960	4900	6591	11491
200-100-0	315	614	929	--	110	110	9409	7180	16589	4786	6638	11424
200-0-100	452	655	1107	--	154	154	8198	7038	15236	4598	5982	10580
200-100-100	381	694	1075	--	128	128	8807	7885	16692	3941	5793	9734

TABLE II

ANNUAL PRECIPITATION AND SUPPLEMENTAL IRRIGATION RECEIVED  
BY BOTH GRASSES DURING BOTH YEARS OF STUDY

Month	<u>Side-oats</u>		<u>Switchgrass</u>		<u>Inches</u>	
	<u>Inches</u>		<u>Inches</u>		<u>Precipitation</u>	
	<u>Applied Water</u>		<u>Applied Water</u>			
	<u>1956</u>	<u>1957</u>	<u>1956</u>	<u>1957</u>	<u>1956</u>	<u>1957</u>
March	--	--	--	--	1.60	1.95
April	6"	--	--	--	.70	5.40
May	6"	--	7"	--	5.50	7.05
June	6"	--	8"	--	1.15	6.25
July	6"	--	7"	6"	3.80	1.00
August	13"	13"	10"	8"	.80	.15
September	12"	6"	--	3"	--	4.40
October	3"	--	--	--	5.80	1.90

TABLE III

MEAN CHEMICAL ANALYSES OF THE BREWER CLAY  
LOAM SOIL PRIOR TO THIS STUDY

Designation of Land	Soil	Available Phosphorus	Available K	%	%
Condition and Crop	pH	Lbs./Acre	Lbs./Acre	O.M.	N
Irrigated Switchgrass	7.5	65(very high)	735	2.47	.124
Irrigated Side-oats	7.5	65(very high)	480	2.42	.118
Dryland Switchgrass	7.4	65(very high)	660	2.53	.124
Dryland Side-oats	7.2	65(very high)	680	2.86	.139

TABLE IV

MEAN CHEMICAL COMPOSITION (IN PERCENT) OF CADDO SWITCHGRASS STOVER  
PRODUCED ON IRRIGATED AND DRYLAND CONDITIONS WITH  
DIFFERENT FERTILITY TREATMENTS IN 1956 AND 1957

Land Condition	Year	% Phosphorus						
		K <sub>1</sub>	K <sub>0</sub>	P <sub>1</sub>	P <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>0</sub>
Irrigated	1956	.097	.084	.089	.092	.098	.090	.082
Irrigated	1957	.098	.094	.111	.083	.082	.093	.116
Dryland	1956	.120	.137	.135	.122	.130	.126	.130
Dryland	1957	.171	.174	.195	.167	.189	.197	.132

Land Condition	Year	% Calcium						
		K <sub>1</sub>	K <sub>0</sub>	P <sub>1</sub>	P <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>0</sub>
Irrigated	1956	.393	.363	.368	.388	.383	.403	.364
Irrigated	1957	.400	.401	.394	.409	.391	.439	.371
Dryland	1956	.377	.418	.426	.370	.415	.409	.370
Dryland	1957	.445	.431	.437	.489	.454	.426	.435

Land Condition	Year	% Protein						
		K <sub>1</sub>	K <sub>0</sub>	P <sub>1</sub>	P <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>0</sub>
Irrigated	1956	4.24	4.61	4.00	4.58	4.06	4.42	4.39
Irrigated	1957	4.28	3.90	4.16	3.86	4.12	4.42	3.49
Dryland	1956	5.58	6.61	6.24	5.96	6.38	6.09	5.83
Dryland	1957	5.67	5.65	5.83	5.49	5.79	5.92	5.27

TABLE V

THE EFFECT OF FERTILIZER ON DORMANCY IN FRESHLY HARVESTED SEED OF CADDO SWITCHGRASS UP TO SEVEN MONTHS AFTER HARVEST AS DETERMINED BY PERIODIC GERMINATION AND REPORTED IN PERCENTAGES

Fertility Treatment	Percent Germination					
	1 Month		3 Months		7 Months	
	Irr.	Dry	Irr.	Dry	Irr.	Dry
0-0-0	27.8	26.5	58.0	48.8	61.8	51.5
0-0-100	27.0	27.5	65.8	48.8	74.5	45.5
0-100-0	36.8**	40.8**	62.0	59.5**	65.2	62.5**
0-100-100	28.8	24.0	67.3	45.5	69.8	38.5
100-0-0	33.0	36.5**	59.5	59.5**	62.8	69.8**
100-0-100	23.0	21.3	68.0**	54.5	65.8	52.2
100-100-0	28.8	36.5**	61.3	38.8	74.2	47.2
100-100-100	33.0	18.0	52.5	43.5	69.5	45.5
200-0-0	35.0	27.0	66.0	48.5	63.5	40.0
200-0-100	40.8**	23.8	53.5	41.5	63.0	41.5
200-100-0	32.0	16.0	66.5	33.8	71.5	28.2
200-100-100	30.8	26.0	61.3	46.0	70.5	44.0

\*\* significantly different at the 1% level, as shown by Analyses of Variance, Tables XIII, XIV, XVI, XVII, and XVIII, Appendix.

### Coronado Side-oats Grama

The broadcast application of fertilizer treatments to the second crop of Coronado side-oats grama grass under irrigation immediately following removal of the first crop in 1956 (Table XXI) had no effect on yield of seed or stover produced.

Due to an unfavorable fertilizer and soil moisture relationship which existed in one section of the side-oats grama field under irrigation, as shown in Figure 3, only three of the four plots were harvested for each fertilizer treatment in 1957. This area was excluded from the study since it contained one each of all twelve treatments. On the three harvested plots, early spring application of fertilizer treatments for production of the first seed crop in 1957 had a significant effect on seed yield, but no differences were measured in the amount of stover produced. Significantly higher seed yields were obtained from plots receiving the 200-100-100 pound rate of fertilizer per acre. An average of 592 pounds of seed per acre was produced with this fertility treatment in comparison to an average of 336 pounds of seed per acre for the check plots.

The irrigated plots treated with phosphorus and potassium alone and in combination and the check matured earlier than the plots receiving nitrogen. Since all plots were harvested at the same time to avoid loss in shattering of the earlier maturing plots, bias was injected into the data. The plots that were not as mature had a larger percentage of inert matter and light seeds. This factor may have been responsible for the inability to measure significant differences in yield due to nitrogen fertilization in the second crop of side-oats grama in 1957 as computations were not made until after cleaning. A difference in number of seed heads and forage produced could be seen in comparing plots in the field as shown in Figure 4, but no statistical or mathematical difference could be demonstrated.

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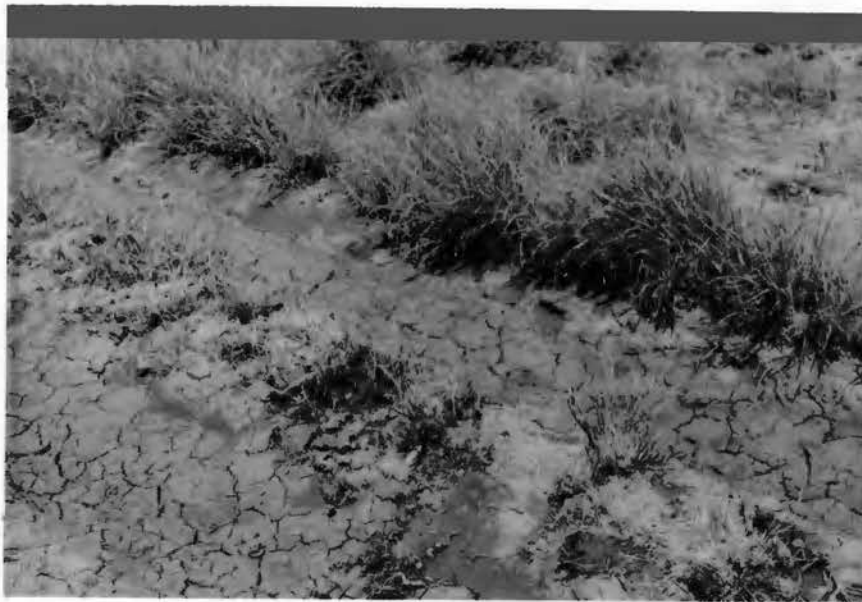


Figure 3. The unfavorable condition above existing under irrigation in one section of the side-oats grama field was more pronounced in the plots which received 100 and 200 pound rates of nitrogen alone and in combination with phosphorus and/or potassium. This condition was apparently due to the high rates of fertilizers used, brought on by standing water. The check or border row on right was not notably hurt. A reduction in stand and vigor can be seen from the row on the left which received a 200-100-0 fertilizer treatment two years in succession.



Figure 4. The irrigated side-oats grama plot (left) which received a 100-100-100 pound rate of fertilizer appeared to produce a larger amount of seed stalks and stover in comparison to border row (right).



Figure 5. The application of 100 pounds of phosphorus to side-oats grama under irrigation (left) resulted in little difference in growth and seed stalk production in comparison to border (right).

Seed yields produced by side-oats grama under dryland conditions (Table XXI) were not increased with fertilizer during the period of this study. The significant difference in stover production from plots which received a fertilizer application of 100-100-0 in 1957 was probably due to the variability in the stand rather than to the effect of the fertilizer treatment. Even though 1957 was a more favorable year than 1956, under dryland conditions lower stover yields were obtained. The residual effect of the fertilizer applied in 1956 plus the fertilizer applied in 1957 seemed to have a harmful effect on the yield of stover produced. This was particularly true when 200 pounds of nitrogen were used alone or in combination.

The two year total of side-oats grama seed produced under irrigation (Table XXI) was approximately fifteen times greater per acre than the yields obtained under dryland. Stover yields produced per acre under irrigation in comparison to dryland were from 2.0 to approximately 4.0 tons greater.

Lodging did not occur under dryland conditions in 1956 or 1957. However, under irrigation lodging occurred on all plots receiving nitrogen alone and in combination with phosphorus and/or potassium. No lodging was observed in the check, nor the plots treated with phosphorus and potassium alone or in combination.

From samples taken prior to the seed harvest in 1957, it was found (Table XXII) that all fertilizer treatments applied to side-oats grama gave an increase in percent seed set under irrigation. Under dryland, however, the application of fertilizer seemed to have the opposite effect on seed set (Table XXIII), with the exception of those plots treated with phosphorus alone which gave a significant increase in percent caryopses

in comparison to the check plots. Percent caryopses or seed set was twice as great under irrigation as that obtained under dryland conditions.

Caryopses of freshly harvested seed from each fertility treatment from both irrigated and dryland plots of side-oats grama (Table XXIV) did not have the length of dormancy that was found in switchgrass. The application of fertilizer caused a significant increase in percent early dormancy in seed harvested from the irrigated plots. Fresh seed harvested from the fertilized plots on dryland conditions did not show any differences in percent germination due to fertilizer rates. No difference in percent germination was obtained from irrigated or dryland seed groups three months after harvest. Each seed group from each fertility treatment, from both irrigated and dryland, germinated in excess of 90%. After three months of storage, dormancy could not be considered a problem in the 1957 seed crop of Coronado side-oats grama.

As shown in Table XXV, the protein content of side-oats grama stover harvested from the second crop under irrigation in 1956 and 1957, and from the single crop harvested in 1956 and 1957 under dryland conditions, showed no difference within land condition and crop due to fertilizer application. However, an increase in protein was obtained in the first stover crop produced under irrigation in 1957 from all plots receiving fertilizer treatments. In 1957, the phosphorus content of stover was not increased with any fertilizer treatment. A slightly higher phosphorus content was obtained under irrigation in 1957 where no nitrogen fertilizer was applied. The phosphorus content of stover was consistently higher under dryland conditions than under irrigated. The protein, calcium, and phosphorus content of the stover was higher in the first crop than in the second under irrigation.

TABLE XXI

MEAN YIELD IN POUNDS OF CORONADO SIDE-OATS GRAMA SEED AND STOVER PRODUCED PER ACRE PER TREATMENT  
UNDER IRRIGATION AND DRYLAND IN 1956 AND 1957

Treatment	Seed Yields (Pounds Per Acre)						Stover Yields (Pounds Per Acre)					
	Dryland		2 Yr. Total	Irrigated			Dryland			Irrigated		
	1956	1957		2nd Crop 1956	1st & 2nd 1957	2 Yr. Total	1956	1957	2 Yr. Total	1956	Combined 1957	2 Yr. Total
0-0-0	--	93	93	436	680	1116	1430	844	2274	2521	4288	6809
0-100-0	--	113	113	516	660	1176	1311	927	2238	2598	4189	6787
0-0-100	--	123	123	529	735	1264	1332	808	2140	2580	5314	7894
0-100-100	--	85	85	396	570	966	1222	702	1924	2386	3894	6280
100-0-0	--	99	99	559	815	1374	1322	1013	2335	2925	6299	9224
100-100-0	--	55	55	584	766	1340	1208	752	1957	2896	5733	8629
100-0-100	--	90	90	684	841	1525	1081	1020	2101	2823	5762	8585
100-100-100	--	59	59	547	1000*	1547	1503	578	2081	2768	5568	8336
200-0-0	--	81	81	653	935	1588	1201	476	1677	3055	5512	8567
200-100-0	--	127	127	540	966	1506	1482	779	2261	2779	6423	9202
200-0-100	--	93	93	476	749	1225	1269	644	1913	2633	4899	7532
200-100-100	--	74	74	638	977*	1615	1124	403	1527	3091	6171	9262

\* Significantly different at the 5% probability level, in the first crop harvested in June, 1957, as shown by the Analysis of Variance, Table XXIX, Appendix.

TABLE XXII

ANALYSIS OF VARIANCE OF THE PERCENT CARYOPSES OBTAINED FROM HAND-STRIPPED SAMPLES HARVESTED FROM EACH FERTILIZED PLOT OF IRRIGATED CORONADO SIDE-OATS GRAMA IN 1957

	Fertilizer Treatment											
	0-0-0 T <sub>1</sub>	0-0-1 T <sub>2</sub>	0-1-0 T <sub>3</sub>	0-1-1 T <sub>4</sub>	1-1-1 T <sub>5</sub>	1-0-0 T <sub>6</sub>	1-1-0 T <sub>7</sub>	1-0-1 T <sub>8</sub>	2-0-0 T <sub>9</sub>	2-1-0 T <sub>10</sub>	2-0-1 T <sub>11</sub>	2-1-1 T <sub>12</sub>
1	11.0	15.9	18.0	16.2	21.0	21.3	15.9	15.6	12.2	17.9	18.8	26.6
2	13.1	14.9	15.4	14.2	14.7	16.8	17.5	18.3	14.7	15.3	25.0	29.4
3	12.6	22.2	17.0	18.6	23.2	21.3	16.5	22.6	15.7	13.9	15.7	17.8
4	15.4	16.4	21.0	16.0	17.3	18.9	17.2	15.9	21.8	13.4	20.4	20.2
$\bar{X}$	13.0	17.4	17.8	16.3	19.0	19.6	16.8	18.1	16.1	15.1	19.9	23.5

A.O.V. Source	D.F.	S.S.	M.S.	F.
Total	47	667.79		
Treatment	11	313.9	28.54	2.903*
Error	36	353.89	9.83	

Multiple Range:

0-0-0 T <sub>1</sub>	2-1-0 T <sub>10</sub>	2-0-0 T <sub>9</sub>	0-1-1 T <sub>4</sub>	1-1-0 T <sub>7</sub>	0-0-1 T <sub>2</sub>	0-1-0 T <sub>3</sub>	1-0-1 T <sub>8</sub>	1-1-1 T <sub>5</sub>	1-0-0 T <sub>6</sub>	2-0-1 T <sub>11</sub>	2-1-1 T <sub>12</sub>
13.0	15.1	16.1	16.3	16.8	17.4	17.8	18.1	19.0	19.6	19.9	23.5

Note: Any two means underscored by the same line are not significantly different at the 5% level.

TABLE XXIII

ANALYSIS OF VARIANCE OF THE PERCENT CARYOPSES OBTAINED FROM HAND-STRIPPED SAMPLES HARVESTED FROM EACH FERTILIZED PLOT UNDER DRYLAND CONDITION IN 1957

	Fertilizer Treatment											
	0-0-0 T <sub>1</sub>	0-0-1 T <sub>2</sub>	0-1-0 T <sub>3</sub>	0-1-1 T <sub>4</sub>	1-1-1 T <sub>5</sub>	1-0-0 T <sub>6</sub>	1-1-0 T <sub>7</sub>	1-0-1 T <sub>8</sub>	2-0-0 T <sub>9</sub>	2-1-0 T <sub>10</sub>	2-0-1 T <sub>11</sub>	2-1-1 T <sub>12</sub>
1	8.0	4.4	14.0	6.0	3.1	4.7	4.1	5.2	5.6	7.6	6.6	6.1
2	7.0	4.1	11.0	6.2	3.9	4.0	3.4	3.7	5.8	7.7	6.3	4.6
3	7.0	4.4	11.5	7.1	3.8	5.3	4.3	4.0	5.9	7.3	5.9	4.7
4	5.7	4.3	11.1	7.6	3.5	4.5	3.3	3.8	5.4	8.0	5.9	5.6
$\bar{X}$	6.9	4.3	11.9	6.7	3.8	4.6	3.8	4.2	5.7	7.6	6.2	5.3

<u>A.O.V.</u>				
Source	D.F.	S.S.	M.S.	F.
Total	47	249.9		
Treatment	11	233.7	21.27	47.26**
Error	36	16.2	.45	

Multiple Range:

1-1-1 T <sub>5</sub>	1-1-0 T <sub>7</sub>	1-0-1 T <sub>8</sub>	0-0-1 T <sub>2</sub>	1-0-0 T <sub>6</sub>	2-1-1 T <sub>12</sub>	2-0-0 T <sub>9</sub>	2-0-1 T <sub>11</sub>	0-1-1 T <sub>4</sub>	0-0-0 T <sub>1</sub>	2-1-0 T <sub>10</sub>	0-1-0 T <sub>3</sub>
3.8	3.8	4.2	4.3	4.6	5.3	5.7	6.2	6.7	6.9	7.6	11.9

Note: Any two means underscored by the same line are not significantly different at the 1% level.

TABLE XXIV

THE EFFECT OF FERTILIZER ON DORMANCY IN FRESHLY HARVESTED SIDE-OATS  
GRAMA SEED IN 1957 FROM IRRIGATED AND DRYLAND PLOTS

Treatment	Percent Germination			
	Irrigated		Dryland	
	1 Month	3 Months	1 Month	3 Months
0-0-0	61*	94	51	95
0-0-100	50	98	52	96
0-100-0	42	96	52	98
0-100-100	59*	98	53	98
100-0-0	55	97	52	96
100-100-0	58*	99	61	95
100-0-100	42	90	62	95
100-100-100	27	98	49	95
200-0-0	48	95	52	97
200-100-0	56	95	56	98
200-0-100	47	97	55	97
200-100-100	64*	98	58	95

\* Significantly higher at the 5% level, as shown by Analysis of Variance, Table XXXV, Appendix.

TABLE XXV

MEAN CHEMICAL COMPOSITION (IN PERCENT) OF CORONADO SIDE-OATS GRAMA STOVER  
PRODUCED ON IRRIGATED AND DRYLAND CONDITIONS WITH  
DIFFERENT FERTILITY TREATMENTS IN 1956 AND 1957

Land Condition	Year	% Phosphorus						
		K <sub>1</sub>	K <sub>0</sub>	P <sub>1</sub>	P <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>0</sub>
Irrigated	1st Crop 1957	.231	.239	.233	.234	.232	.214	.256
Irrigated	2nd Crop 1957	.150	.155	.158	.147	.131	.124	.203
Dryland	1957	.332	.315	.328	.319	.329	.335	.308
Land Condition	Year	% Calcium						
		K <sub>1</sub>	K <sub>0</sub>	P <sub>1</sub>	P <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>0</sub>
Irrigated	1st Crop 1957	.302	.332	.301	.309	.350	.327	.273
Irrigated	2nd Crop 1957	.284	.299	.290	.293	.297	.264	.341
Dryland	1957	.363	.307	.320	.350	.348	.372	.293
Land Condition	Year	% Protein						
		K <sub>1</sub>	K <sub>0</sub>	P <sub>1</sub>	P <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>0</sub>
Irrigated	2nd Crop 1956	5.25	5.38	5.56	5.07	5.75	5.87	4.33
Irrigated	1st Crop 1957	8.98	8.88	8.62	9.25	9.68	10.06	7.06
Irrigated	2nd Crop 1957	6.16	5.92	6.07	6.00	6.44	6.60	5.07
Dryland	1956	8.75	8.99	8.98	8.76	8.44	9.48	8.69
Dryland	1957	10.07	10.36	10.27	10.17	10.62	10.00	10.03

## SUMMARY AND CONCLUSIONS

Results of this study indicate neither switchgrass nor side-oats grama require high rates of fertilizer for maximum yields of seed and forage.

No response in yield of seed or stover due to fertilizer applied could be measured on switchgrass grown on a Brewer clay loam soil of high fertility in 1956 or 1957 under dry or irrigated conditions.

When established in cultivated rows for seed production on a fertile soil, switchgrass does not need added fertilizer until after the second year of production under irrigation and after three to four years under dryland.

Seed yield response in switchgrass due to fertilization may be masked in some years, when undesirable temperatures and hot, dry winds prevail during the bloom and dough stages. For this reason, response to fertilizer may be best measured by the production of forage, assuming that under optimum conditions there is a positive correlation between forage and seed production.

Seed yields under irrigation on both switchgrass and side-oats grama were much greater for the two year period than those produced on dry land. Switchgrass produced 5 to 9 times more seed per acre, and side-oats grama 15 times more under irrigation than on dryland.

Switchgrass stover yield was 2.5 tons greater under irrigation in comparison to yields obtained on dryland for the two year period.

Side-oats grama produced 2.0 to 4.0 tons more stover under

irrigation than under dryland.

The quality of switchgrass stover appears to be higher under dryland conditions but apparently diminishes in quality in wet years.

Side-oats grama and switchgrass stover produced under irrigation has a lower phosphorus and protein content than stover produced on dryland. Under both land conditions the quality of the first stover crop of side-oats grama is very high. Under irrigation, the protein content of side-oats increases with nitrogen application, but it is not significantly different between nitrogen rates. There is a significant difference in protein content of side-oats stover between the first and second crops.

This study indicates that heavy fertilization along with unfavorable water conditions results in loss of stand and plant vigor in side-oats grama.

A significant increase in seed yields was measured on side-oats grama under irrigation from the early spring application of 100 and 200 pounds of nitrogen alone and in combination with 100 pounds each of phosphorus and potassium in 1957.

The early seed maturity of side-oats grama in the phosphorus and potassium treated plots alone and in combination and the check under irrigation make it difficult to measure the effect of fertilizer on seed yields.

Severe lodging occurred under irrigation in both side-oats and switchgrass when fertilized with 100 and 200 pound rates of nitrogen alone or in combination with 100 pounds of phosphorus and/or potassium.

Little or no lodging occurred when 100 pounds of phosphorus and/or potassium were applied alone or in combination on either grass.

All fertility treatments applied to irrigated side-oats grama gave an increase in seed set when compared to the check plots.

The application of fertilizer to side-oats grama on dryland, with the exception of phosphorus, decreased the percent seed set.

Under irrigation the seed set of side-oats grama is twice as great as that obtained on dryland.

There is an indication that the fertilization of switchgrass with nitrogen or phosphorus may have a favorable effect on germination of freshly harvested mature seed.

Fewer dormant switchgrass seeds are produced under irrigation than under dryland, but the stage of maturity at the time of harvest may have an effect on the length of dormancy involved.

Fertilizer apparently had no effect on germination or dormancy of freshly harvested side-oats grama seed produced on either land condition.

No dormancy was found in Coronado side-oats grama after three months of storage at room temperature.

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**APPENDIX**

TABLE VI

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON SEED YIELDS  
IN POUNDS PER ACRE OF CADDO SWITCHGRASS PRODUCED  
UNDER IRRIGATION IN 1956

---

SOURCE	DF	SS	MS	F
Total	47	555,148		
Treatment	11	197,791	17,981.00	1.811
Error	36	357,357	9,926.58	

---

C.V. = 23.8%

---

TABLE VII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT OF CADDO  
SWITCHGRASS STOVER YIELDS PRODUCED UNDER IRRIGATION IN 1956.

---

SOURCE	DF	SS	MS	F
Total	47	62,794,862		
Treatment	11	11,071,127	1,006,466	.7005
Error	36	51,723,735	1,436,770	

---

C.V. = 14%

---

TABLE VIII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT OF CADDO  
SWITCHGRASS SEED YIELDS IN POUNDS PER ACRE PRODUCED UNDER  
IRRIGATION IN 1957

---

SOURCE	DF	SS	MS	F
Total	47	608,215		
Treatment	11	112,366	10,215	--
Error	36	495,849	13,774	

---

C.V. = 19%

---

TABLE IX

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON CADDO  
SWITCHGRASS STOVER YIELDS PRODUCED UNDER IRRIGATION IN 1957

---

SOURCE	DF	SS	MS	F
Total	47	25,171,348		
Treatment	11	4,083,897	371,263.36	.6653
Error	36	20,087,451	557,984.75	

---

C.V. = 10.33%

---

TABLE X

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON CADDO  
SWITCHGRASS STOVER YIELDS PRODUCED ON DRYLAND IN 1956

---

SOURCE	DF	SS	MS	F
Total	47	65,793,905		
Treatment	11	13,241,571	1,203,779	.8246
Error	36	52,552,334	1,459,787	

---

C.V. = 27%

---

TABLE XI

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON CADDO  
SWITCHGRASS SEED YIELDS PRODUCED ON DRYLAND IN 1957

---

SOURCE	DF	SS	MS	F
Total	47	319,762.3		
Treatment	11	114,485.6	10,407.78	1.825
Error	36	205,276.7	5,702.13	

---

C.V. = 44%

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TABLE XII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON CADDO  
SWITCHGRASS STOVER YIELDS PRODUCED ON DRYLAND IN 1957

---

SOURCE	DF	SS	MS	F
Total	47	28,187,503		
Treatment	11	6,372,639	579,330	.8695
Error	36	21,814,864	605,968	

---

C.V. = 13%

---

TABLE XIII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER ON THE PERCENT GERMINATION OF FRESHLY HARVESTED  
CADD O SWITCHGRASS SEED PRODUCED UNDER IRRIGATION IN 1957

---

SOURCE	DF	SS	MS	F
Total	47	1963.20		
Reps	3	128.37	42.79	
Treatment	11	1008.70	91.70	3.66**
Error	33	826.13	25.03	

---

C.V. = 16%

Multiple Range:

1-1-0	0-0-1	0-0-0	0-1-1	1-1-1	2-1-1	2-0-1	1-0-0	1-0-1	2-0-0	0-1-0	2-1-0
T <sub>6</sub>	T <sub>2</sub>	T <sub>1</sub>	T <sub>3</sub>	T <sub>7</sub>	T <sub>12</sub>	T <sub>11</sub>	T <sub>5</sub>	T <sub>8</sub>	T <sub>9</sub>	T <sub>4</sub>	T <sub>10</sub>
23.0	27.0	27.8	28.8	28.8	30.8	32.0	33.0	33.0	35.0	36.8	40.8

---



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Note: Any two means underscored by the same line are not significantly different at the 1% level.

---

TABLE XIV

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE PERCENT GERMINATION OF IRRIGATED  
CADDO SWITCHGRASS SEED THREE MONTHS AFTER HARVEST

---

SOURCE	DF	SS	MS	F
Total	47	1785.92		
Reps	3	41.42	13.807	
Treatments	11	1196.92	108.811	6.558**
Error	33	547.58	16.593	

---

C.V. = 6.5%

Multiple Range:

1-1-1	2-0-1	0-0-0	1-0-0	2-1-1	1-1-0	0-1-0	0-0-1	2-0-0	2-1-0	0-1-1	1-0-1
T <sub>7</sub>	T <sub>11</sub>	T <sub>1</sub>	T <sub>5</sub>	T <sub>12</sub>	T <sub>6</sub>	T <sub>4</sub>	T <sub>2</sub>	T <sub>9</sub>	T <sub>10</sub>	T <sub>3</sub>	T <sub>8</sub>
52.5	53.5	58.0	59.5	61.3	61.3	62.0	65.8	66.0	66.5	67.3	68.0

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Note: Any two means underscored by the same line are not significantly different at the 1% level.

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TABLE XV

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE  
 PERCENT GERMINATION OF IRRIGATED CADDO SWITCHGRASS SEED  
 SEVEN MONTHS AFTER HARVEST

---

SOURCE	DF	SS	MS	F
Total	47	2540.67		
Reps	3	249.50	83.17	1.99
Treatment	11	913.17	83.02	1.988
Error	33	1378.00	41.76	

---

TABLE XVI

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE PERCENT GERMINATION OF  
FRESHLY HARVESTED CADDO SWITCHGRASS SEED PRODUCED ON DRYLAND IN 1957

SOURCE	DF	SS	MS	F
Total	47	2896.98		
Reps	3	15.23	5.08	
Treatment	11	2502.73	227.52	19.802**
Error	33	379.02	11.49	

C.V. = 12%

\*\* significant at the 1% level

Multiple Range:

2-1-0	1-1-1	1-0-1	2-0-1	0-1-1	2-1-1	0-0-0	2-0-0	0-0-1	1-0-0	1-1-0	0-1-0
T <sub>10</sub>	T <sub>7</sub>	T <sub>8</sub>	T <sub>11</sub>	T <sub>3</sub>	T <sub>12</sub>	T <sub>1</sub>	T <sub>9</sub>	T <sub>2</sub>	T <sub>5</sub>	T <sub>6</sub>	T <sub>4</sub>
16.0	18.0	21.3	23.8	24.0	26.0	26.5	27.0	27.5	36.5	36.5	40.8

Note: Any two means underscored by the same line are not significantly different at the 1% level.

TABLE XVII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE PERCENT GERMINATION OF CADDO  
SWITCHGRASS SEED PRODUCED ON DRYLAND THREE MONTHS AFTER HARVEST

SOURCE	DF	SS	MS	F
Total	47	3445.25		
Reps	3	70.25	23.417	
Treatment	11	2659.25	241.75	11.146**
Error	33	715.75	21.689	

C.V. = 9.8%

\*\* significant at the 1% level

Multiple Range:

2-1-0	1-1-0	2-0-1	1-1-1	0-1-1	2-1-1	2-0-0	0-0-1	0-0-0	1-0-1	1-0-0	0-1-0
T <sub>10</sub>	T <sub>6</sub>	T <sub>11</sub>	T <sub>7</sub>	T <sub>3</sub>	T <sub>12</sub>	T <sub>9</sub>	T <sub>2</sub>	T <sub>1</sub>	T <sub>8</sub>	T <sub>5</sub>	T <sub>4</sub>
33.8	38.8	41.5	43.5	45.5	46.0	48.5	48.8	48.8	54.5	59.5	59.5

Note: Any two means underscored by the same line are not significantly different at the 1% level.

TABLE XVIII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER ON THE PERCENT GERMINATION OF CADDO SWITCHGRASS  
SEED PRODUCED ON DRYLAND SEVEN MONTHS AFTER HARVEST

---

SOURCE	DF	SS	MS	F
Total	47	6265.92		
Reps	3	250.42	83.47	3.78
Treatment	11	5286.92	480.63	21.77**
Error	33	728.58	22.08	

---

\*\* significant at the 1% level

Multiple Range:

2-1-0	0-1-1	2-0-0	2-0-1	2-1-1	1-1-1	0-0-1	1-1-0	0-0-0	1-0-1	0-1-0	1-0-0
T <sub>10</sub>	T <sub>4</sub>	T <sub>9</sub>	T <sub>11</sub>	T <sub>12</sub>	T <sub>8</sub>	T <sub>3</sub>	T <sub>6</sub>	T <sub>1</sub>	T <sub>7</sub>	T <sub>2</sub>	T <sub>5</sub>
28.2	38.5	40.0	41.5	44.0	45.5	45.5	47.2	51.5	52.2	62.5	69.8

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Note: Any two means underscored by the same line are not significantly different at the 1% level.

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TABLE XIX

PROXIMATE CHEMICAL ANALYSES OF IRRIGATED CADDO SWITCHGRASS STOVER  
FROM EACH FERTILITY TREATMENT FOR BOTH YEARS OF STUDY

Treatment	% Ash		% Protein		% Fat		% Fiber		% N.F.E.		% Ca		% P	
	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957
0-0-0	6.87	6.84	5.69	3.17	1.52	1.43	42.44	42.85	43.48	45.71	.375	.406	.078	.095
0-100-0	6.50	6.72	4.06	3.76	.92	1.54	41.09	44.07	47.43	43.91	.385	.348	.079	.132
0-0-100	6.90	6.77	4.19	3.46	1.57	1.15	40.79	43.24	46.55	45.38	.365	.329	.100	.086
0-100-100	6.35	6.68	3.63	3.57	.86	1.38	42.38	43.08	46.78	45.29	.330	.402	.072	.151
100-0-0	6.44	7.71	3.94	4.05	.81	1.55	40.48	40.82	48.33	45.87	.325	.471	.092	.076
100-0-100	6.81	6.53	4.00	3.68	1.68	1.53	39.07	42.56	48.44	45.70	.365	.373	.099	.084
100-100-0	7.44	5.92	4.50	3.94	.70	1.27	33.23	42.58	54.13	46.29	.428	.351	.104	.069
100-100-100	5.72	7.79	3.81	4.80	.43	1.65	39.64	42.25	50.40	43.51	.352	.368	.098	.098
200-0-0	6.45	6.43	3.94	3.48	.92	1.15	41.23	44.29	47.46	44.65	.355	.384	.073	.068
200-0-100	6.10	7.80	3.81	4.27	.96	1.53	44.82	41.55	44.31	44.85	.375	.421	.082	.112
200-100-0	7.60	9.30	5.25	5.04	1.64	1.69	41.13	38.88	44.38	45.09	.480	.498	.103	.105
200-100-100	6.65	8.81	4.69	4.88	.60	1.44	34.28	40.77	53.78	44.10	.400	.453	.102	.086

TABLE XX

PROXIMATE CHEMICAL ANALYSES OF DRYLAND CADDO SWITCHGRASS STOVER  
FROM EACH FERTILITY TREATMENT FOR BOTH YEARS OF STUDY

Treatment	% Ash		% Protein		% Fat		% Fiber		% N.F.E.		% Ca		% P	
	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957
0-0-0	7.60	7.19	7.25	5.20	1.94	1.70	34.19	39.63	49.02	39.63	.445	.459	.163	.122
0-100-0	5.62	8.90	5.37	5.47	1.82	1.83	36.31	39.73	50.88	39.73	.370	.469	.107	.134
0-0-100	4.95	7.78	4.13	5.14	1.44	1.85	39.84	39.23	49.64	39.23	.260	.449	.086	.117
0-100-100	6.95	6.86	6.56	5.27	1.00	1.77	34.04	40.25	51.45	40.25	.405	.362	.165	.155
100-0-0	6.67	6.72	7.00	5.33	.92	1.72	33.96	37.26	51.45	37.26	.405	.395	.137	.195
100-0-100	6.10	8.11	6.25	6.09	1.52	2.01	39.94	36.36	46.44	36.36	.380	.453	.118	.226
100-100-0	6.10	8.10	6.00	6.09	1.52	1.98	39.94	36.76	46.44	36.76	.380	.476	.118	.133
100-100-100	6.63	7.37	6.25	5.67	1.49	1.83	36.76	40.61	48.87	40.61	.430	.491	.130	.201
200-0-0	7.14	6.86	6.94	5.77	.82	1.96	35.00	40.20	50.10	45.21	.450	.403	.135	.158
200-0-100	6.82	7.54	6.87	6.05	.95	1.86	33.92	39.53	51.44	45.02	.460	.409	.148	.207
200-100-0	5.16	7.36	4.44	5.39	1.59	2.08	39.44	36.95	49.37	48.22	.280	.453	.093	.175
200-100-100	6.72	7.97	6.13	6.45	1.57	2.21	38.60	37.30	46.98	37.30	.445	.437	.126	.247

TABLE XXVI

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT OF CORONADO  
SIDE-OATS GRAMA STOVER YIELDS PRODUCED UNDER IRRIGATION IN 1956

---

SOURCE	DF	SS	MS	F
Total	47	6,923,967	147,318	
Treatment	11	2,070,342	188,213	1.39
Error	36	4,853,625	134,823	

---

C.V. = 13.3%

---

TABLE XXVII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON SEED YIELDS  
OF CORONADO SIDE-OATS GRAMA PRODUCED UNDER IRRIGATION IN 1956

---

SOURCE	DF	SS	MS	F
Total	47	1,668,233		
Treatment	11	325,712	29,610	.7609
Error	36	1,342,521	37,292	

---

C.V. = 37%

---

TABLE XXVIII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON CORONADO  
SIDE-OATS GRAMA STOVER YIELDS PRODUCED ON DRYLAND IN 1956

---

SOURCE	DF	SS	MS	F
Total	47	5,135,441		
Treatment	11	784,448	71,313	.5900
Error	36	4,350,993	120,860	

---

TABLE XXIX

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE FIRST SEED CROP  
OF CORONADO SIDE-OATS GRAMA PRODUCED UNDER IRRIGATION IN 1957

SOURCE	DF	SS	MS	F							
Total	35	959,034.9									
Treatment	11	555,364.6	50,487.7	3.002*							
Error	24	403,670.3	16,819.6								
C.V. = 31%											
<u>Multiple Range:</u>											
0-1-1	1-0-1	0-0-1	0-1-0	0-0-0	2-1-0	1-0-0	1-1-0	2-0-0	2-0-1	1-1-1	2-1-1
T <sub>4</sub>	T <sub>7</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>1</sub>	T <sub>10</sub>	T <sub>5</sub>	T <sub>6</sub>	T <sub>9</sub>	T <sub>11</sub>	T <sub>8</sub>	T <sub>12</sub>
175	295	314	322	336	346	409	479	508	576	582	592

Note: Any two means underscored by the same line are not significantly different at the 5% level.

TABLE XXX

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE FIRST  
STOVER CROP OF CORONADO SIDE-OATS GRAMA PRODUCED UNDER  
IRRIGATION IN 1957

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SOURCE	DF	SS	MS	F
Total	35	29,158,037		
Treatment	11	10,267,827	933,438.8	1.1859
Error	24	18,890,210	787,092.1	

---

C.V. = 30%

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TABLE XXXI

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE SECOND  
SEED CROP OF CORONADO SIDE-OATS GRAMA PRODUCED UNDER  
IRRIGATION IN 1957

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SOURCE	DF	SS	MS	F
Total	35	435,289.6		
Treatment	11	23,180.3	2,107.3	.1227
Error	24	412,109.3	17,171.2	

---

C.V. = 33%

---

TABLE XXXII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE SECOND  
STOVER CROP OF CORONADO SIDE-OATS GRAMA PRODUCED UNDER  
IRRIGATION IN 1957

---

SOURCE	DF	SS	MS	F
Total	35	11,098,545.6		
Treatment	11	4,450,117.7	404,556.2	1.4603
Error	24	6,648,427.9	277,017.8	

---

C.V. = 22%

---

TABLE XXXIII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE TOTAL  
SEED YIELD OF CORONADO SIDE-OATS GRAMA PRODUCED  
UNDER IRRIGATION IN 1957

SOURCE	DF	SS	MS	F
Total	35	1,647,792.75		
Treatment	11	632,937.41	57,539.8	1.3607
Error	24	1,014,855.34	42,285.6	
C.V. = 25%				

TABLE XXXIV

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE TOTAL  
STOVER YIELD OF CORONADO SIDE-OATS GRAMA PRODUCED  
UNDER IRRIGATION IN 1957

SOURCE	DF	SS	MS	F
Total	35	54,788,555		
Treatment	11	23,749,558	2,159,050.7	1.6694
Error	24	31,038.997	1,293,291.5	
C.V. = 21%				

TABLE XXXV

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE PERCENT GERMINATION OF FRESHLY HARVESTED  
CORONADO SIDE-OATS GRAMA SEED PRODUCED UNDER IRRIGATION

SOURCE	DF	SS	MS	F
Total	47	6,001.4		
Reps	3	204.2	68.06	
Treatment	11	4,608.8	418.98	16.351*
Error	33	1,188.4	36.01	

Multiple Range:

1-1-1	0-1-0	1-0-1	2-0-1	2-0-0	0-0-1	1-0-0	2-1-0	1-1-0	0-1-1	0-0-0	2-1-1
T <sub>5</sub>	T <sub>3</sub>	T <sub>7</sub>	T <sub>11</sub>	T <sub>9</sub>	T <sub>2</sub>	T <sub>8</sub>	T <sub>10</sub>	T <sub>6</sub>	T <sub>4</sub>	T <sub>1</sub>	T <sub>12</sub>
27.2	42.5	42.5	47.2	47.8	49.7	54.7	56.2	57.7	59.2	61.0	64.0

Note: Any two means underscored by the same line are not significantly different at the 5% level.

TABLE XXXVI

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE PERCENT GERMINATION OF IRRIGATED  
CORONADO SIDE-OATS GRAMA SEED THREE MONTHS AFTER HARVEST

SOURCE	DF	SS	MS	F
Total	47	435.		
Reps	3	57.	19.00	5.405**
Treatment	11	262.	23.818	6.776**
Error	33	116.	3.515	

<u>Multiple Range:</u>											
1-0-1	0-0-0	2-0-0	2-1-0	0-1-0	1-0-0	2-0-1	0-1-1	1-1-1	2-1-1	0-0-1	1-1-0
T <sub>7</sub>	T <sub>1</sub>	T <sub>9</sub>	T <sub>10</sub>	T <sub>3</sub>	T <sub>8</sub>	T <sub>11</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>12</sub>	T <sub>2</sub>	T <sub>6</sub>
90.5	93.5	95.0	95.5	96.0	97.3	97.5	98.0	98.0	98.2	98.2	98.7

Note: Any two means underscored by the same line are not significantly different at the 1% level.

TABLE XXXVII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON CORONADO SIDE-OATS  
GRAMA STOVER YIELDS PRODUCED ON DRYLAND IN 1957

SOURCE		DF	SS	MS	F
Total		47	7,223,574		
Treatment		11	2,804,994	254,999	2.0775*
Error		36	4,418,580	122,738	

Multiple Range:

2-1-1	2-0-0	1-1-1	2-1-0	0-1-1	1-0-1	2-0-1	0-1-0	0-0-0	0-0-1	1-0-0	1-1-0
T <sub>12</sub>	T <sub>9</sub>	T <sub>8</sub>	T <sub>10</sub>	T <sub>4</sub>	T <sub>7</sub>	T <sub>11</sub>	T <sub>3</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>5</sub>	T <sub>6</sub>
403	476	578	644	702	752	779	808	844	927	1013	1020

Note: Any two means underscored by the same line are not significantly different at the 5% level.

TABLE XXXVIII

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON CORONADO  
SIDE-OATS GRAMA SEED YIELDS PRODUCED ON DRYLAND IN 1957

SOURCE	DF	SS	MS	F
Total	47	88,414.5		
Treatment	11	22,541.75	2,049.	1.117
Error	36	65,972.75	1,832.6	

TABLE XXXIX

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE  
PERCENT GERMINATION OF FRESHLY HARVESTED CORONADO SIDE-OATS  
GRAMA SEED PRODUCED ON DRYLAND IN 1957

SOURCE	DF	SS	MS	F
Total	37	1,448.8		
Reps	2	268.2	134.1	5.610*
Treatment	11	607.4	55.2	2.309
Error	24	573.2	23.9	

TABLE XL

ANALYSIS OF VARIANCE OF THE EFFECT OF FERTILIZER TREATMENT ON THE  
PERCENT GERMINATION OF CORONADO SIDE-OATS GRAMA SEED  
PRODUCED ON DRYLAND THREE MONTHS AFTER HARVEST

SOURCE	DF	SS	MS	F
Total	47	115.5		
Reps	3	13.5	4.500	2.233
Treatment	11	35.5	3.227	1.601
Error	33	66.5	2.015	

TABLE XLI

PERCENT PROTEIN OF THE SECOND STOVER CROP OF CORONADO SIDE-OATS GRAMA  
FROM EACH FERTILITY TREATMENT PRODUCED UNDER BOTH  
IRRIGATED AND DRYLAND CONDITION IN 1956

Treatment	Dryland	Irrigated
	% Protein	% Protein
0-0-0	9.13	4.13
0-100-0	8.13	4.69
0-0-100	8.13	4.31
0-100-100	9.37	4.19
100-0-0	7.94	5.69
100-100-0	8.94	6.31
100-0-100	7.69	5.06
100-100-100	9.19	5.94
200-0-0	10.81	5.81
200-100-0	9.00	5.69
200-0-100	8.88	5.43
200-100-100	9.25	6.56

TABLE XLII

PROXIMATE CHEMICAL ANALYSES OF THE FIRST AND SECOND STOVER CROPS OF CORONADO SIDE-OATS  
GRAMA FROM EACH FERTILITY TREATMENT PRODUCED UNDER IRRIGATION IN 1957

Treatment	% Ash		% Protein		% Fat		% Fiber		% N.F.E.		% Ca.		% P.	
	1st Crop	2nd Crop	1st Crop	2nd Crop	1st Crop	2nd Crop	1st Crop	2nd Crop	1st Crop	2nd Crop	1st Crop	2nd Crop	1st Crop	2nd Crop
0-0-0	12.98	16.17	6.96	5.32	1.67	1.61	35.60	33.05	42.79	43.85	.265	.373	.247	.203
0-100-0	12.61	12.99	6.37	4.67	1.45	1.37	38.62	36.21	40.95	44.76	.244	.289	.260	.217
0-0-100	12.80	11.49	8.00	4.92	1.46	1.27	36.26	37.79	41.48	44.53	.298	.283	.265	.199
0-100-100	13.66	13.11	6.89	5.38	1.65	1.51	35.66	35.47	42.14	44.53	.286	.309	.246	.194
100-0-0	12.86	10.00	10.11	5.91	1.51	.83	34.50	41.22	41.02	42.04	.357	.278	.221	.106
100-100-0	13.55	11.60	9.15	6.54	1.39	1.41	33.68	38.06	42.23	42.39	.342	.314	.235	.129
100-0-100	12.15	12.38	9.70	6.49	1.64	1.16	34.73	37.77	41.78	42.20	.369	.283	.229	.126
100-100-100	11.75	12.39	9.77	6.81	2.49	1.66	36.17	37.00	39.82	42.14	.332	.314	.241	.133
200-0-0	12.18	12.08	10.04	6.95	2.43	1.31	36.84	36.63	38.51	43.03	.348	.262	.239	.131
200-100-0	12.73	11.82	10.69	6.11	2.77	1.23	34.47	36.42	39.34	44.42	.324	.279	.213	.144
200-0-100	12.99	10.47	10.66	6.43	1.47	1.35	34.23	36.59	40.65	45.16	.354	.273	.202	.116
200-100-100	10.81	11.09	8.85	6.92	1.26	1.22	38.50	36.31	40.58	44.46	.280	.243	.201	.132

TABLE XLIII

PROXIMATE CHEMICAL ANALYSES OF THE FIRST STOVER CROP OF CORONADO SIDE-OATS  
GRAMA FROM EACH FERTILITY TREATMENT PRODUCED ON DRYLAND IN 1957

Treatment	% Ash	% Protein	% Fat	% Fiber	% N.F.E.	% Ca.	% P.
0-0-0	15.78	10.06	1.35	34.80	38.01	.231	.282
0-100-0	16.17	10.06	1.46	34.84	37.47	.274	.313
0-0-100	16.73	10.21	1.81	31.60	39.65	.350	.307
0-100-100	16.80	9.79	1.55	33.33	38.53	.315	.325
100-0-0	15.86	10.82	1.47	31.37	40.48	.343	.335
100-100-0	17.37	10.29	1.59	33.21	37.54	.280	.294
100-0-100	16.79	10.30	1.51	33.14	38.26	.367	.341
100-100-100	16.53	11.07	1.28	31.57	39.55	.371	.346
200-0-0	16.43	10.61	1.28	32.68	39.00	.401	.332
200-100-0	17.44	10.34	1.52	32.69	38.01	.311	.333
200-0-100	15.94	9.00	1.46	34.71	37.99	.357	.316
200-100-100	17.81	10.05	1.40	31.82	38.92	.420	.358

## VITA

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candidate for the degree of  
Master of Science

Thesis: THE EFFECT OF FERTILIZERS ON FORAGE AND SEED PRODUCTION, DORMANCY OF FRESHLY HARVESTED SEED AND CHEMICAL COMPOSITION OF STOVER OF CADDO SWITCHGRASS (PANICUM VIRGATUM L.) AND CORONADO SIDE-OATS GRAMA GRASS (BOUTELOUA CURTIPENDULA, (MICHX.) TORR.)

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