Blue Grama Seed Production Studies[1]

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Blue grama, *Bouteloua gracilis,* is an excellent warm season grass over its entire range. It is found from Mexico to the Canadian prairie provinces and from the ninety-sixth meridian as far west as Utah and eastern Californa. It cures out well and makes good winter grazing over much of its area.

Studies in the grass breeding program at Woodward, Oklahoma, have indicated that varieties of blue grama can be developed that would be markedly superior to material grown from seed harvested from native stands. Increase and testing of breeding material has been limited and nearly inhibited by extremely low seed sets at Woodward. Attempts at controlled seed production elsewhere have not been successful.

Commercial seed is harvested from native stands or from seeded pastures. It is seldom harvested from the same area two years in succession. Harvests are made where seed is found. Seed origins and seed quality vary from year to year. In spite of the wide area over which seed harvests are often made, years of relative scarcity of blue grama seed occur.

If consistent seed production on a commercial and profitable scale could be achieved either under cultivation or by proper management of pasture areas, improved strains could be used in seedings and quality of seed on the market would be greatly improved. Both factors would add much to the agricultural economy of the Great Plains and surrounding areas. The work to be reported here is part of continuing studies of blue grama seed production at Woodward.

Review of Literature

Seed production methods with cool-season introduced grasses such as smooth bromegrass (*Bromus inermis* Leyss.) and orchardgrass (*Dactylis glomerata* L.) have been studied by many workers in this country and abroad. Their results have shown that adequate moisture and relatively high fertility levels (particularly of nitrogen) are required for maximum seed production (Buller et al. 1955). Stitt (1954) obtained marked response in seed production of Russian wildrye (*Elymus junceus* Fisch.) with applications of nitrogen as high as 400 pounds per acre under irrigation and 100 pounds per acre dryland (16 inch rainfall, wide row spacings).

Investigations of native grass seed production have been largely limited to field observations. Cornelius (1950) working with several native species, obtained best results with 60 pounds of nitrogen applied in the spring to row plantings. Harlan and Kneebone (1953) obtained marked increases in seed production of switchgrass (*Panicum virgatum* L.) from applications of nitrogen up to 100 pounds per acre.

Studies of seed production of several native grasses in relation to climatic conditions and soil moisture were made by Branson (1941) and Brown (1943) at Hays, Kansas. Both concluded that seed production was directly correlated with soil moisture. In another study at Hays, Riegel (1940) grew blue grama from several sources in the Great Plains. Over a three year period, northern sources bloomed around July 1, southern sources around July 25 and central sources around August 5. He found that central sources had the greatest number of caryopses per 100 florets.

Wolff (1951) pointed out that good yields from native blue grama stands are associated with heavy rainfall at least a month prior to the harvest season and with cool temperatures; best quality seed usually being produced in September and October. Hoover, et al. (1947) stated that blue grama seed production depends on plentiful moisture and cool temperatures at time of blossoming and seed formation.

The effect of insect parasites on grass seed production in this country is largely unknown. Various species of thrips (*Thripidae*) and and gall midges (*Cecidomyidae*) have been shown to reduce seed production of many grass species in Europe (Barnes 1937, 1946). Cornelius (1950) found gall midge larvae in big bluestem (*Andropogon gerardi* Vitman). The writer has observed gall midge larvae in blue grama, sideoats grama (*B. curtipendula* (Michx.) Torr.) and switchgrass. Bailey (1948) found that a thrip (*Chirothrips aculeatus* Bagn.) "completely destroyed the seed of fescue increase plots" at Davis, California in 1947. He stated, "There is doubtless much more injury done by thrips to grains and especially to grass seed crops than is realized."

Roney (1949), in Arizona, controlled thrips (*Chirothrips mexicanus* and *C. falsus* Preisner) with 2% parathion dust and increased bermudagrass (*Cynodon dactylon* (L.) Pers.) seed production from 50 to 450 pounds per acre. Riherd (1954) controlled thrips (*C. mexicanus*) in Rhodes grass (*Chloris gayana* Kunth.) in Texas with dieldrin and reduced the percentage of blasted seeds per head from 91.7 to

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12.3. He observed thrips in florets of other grasses as well.

Materials and Methods

An excellent drilled stand of blue grama was established on Pratt loamy fine sand at Woodward, Oklahoma in 1950 with seed harvested near Marfa, Texas. In 1953, half the area was sprinkler irrigated during the first part of the season, the other half was not. The entire area was mowed at the end of July and no more irrigations were made after that date. The fall crop of heads was sprayed at early bloom with the following treatments: parathion at 1 pound of 15% wettable powder per acre, dieldrex emulsion at 0.25 pound dieldrin per acre, systox at 8 ounces per acre, and check. The experiment was laid out in four randomized complete blocks. A 3½ x 30 foot area of each plot was harvested and sacked when seed was ripe. After drying, the sacks were beaten with rubber hoses to detach heads and florets from stems. Cleaned floret material was weighed and run through a modified hammermill (Kneebone and Brown, 1953) to reduce it to clean caryopses. Final cleaning was done by hand rubbing and screening. Ratios of caryopsis yields to rough seed yields, or caryopsis percentages, were used to compare spray treatments. Rough seed weights were taken to the nearest gram and weights of clean grain to the nearest hundredth of a gram.

Due to extreme drouth the grass was dormant throughout June and July, 1954. A split-split plot randomized block design with four replicates was laid out on the field, using two dates of starting irrigation, August 6 and August 20, as main plots and 50 pounds of nitrogen per acre applied at first watering versus no nitrogen as sub-plots. Sub-plots were further divided by spray treatments. Treatments were dieldrin, parathion and check, using the same rates as in 1953 per application. Two applications were made, at flowering and ten days later. After cutting borders, an area 10 x 16½ feet was harvested from each spray plot. Heads were sickled off, sacked and dried. Sacks were beaten as before, but after weighing the floret material, two 10 gram samples of rough seed from each plot were rubbed to clean grain by hand. Caryopsis percentages were determined from these samples. In addition to seed yields, forage yields under each irrigation and fertilizer treatment were determined.

In 1955, drought was again severe, but sufficient growth occurred that the field was clipped back twice. The grass was dormant from mid-June until watering was started on August 16. A split plot randomized block design in 4 replicates was used. Main plots were fertilizer treatments applied at first watering; 50, 100, 200, 400 pounds of nitrogen per acre. Sub-plots were sprays; dieldrin at 0.25 pound per acre, DDT at 2 pounds 50% wettable powder per acre, and check. Plots were sprayed twice at these rates, at first flowering and two weeks later. In both 1954 and 1955 the source of nitrogen was ammonium nitrate. Fertilizer applications were made with a hand spreader. The 1955 fertilizer plots were superimposed on the plots used in 1954 so that half of the plots at each rate in 1955 were on areas fertilized in 1954 and half were on areas previously used as checks.

Seed and forage samples were taken and processed in 1955 as in 1954 except that caryopsis percentage was determined from one 5 and one 2 gram sample per plot and cleaning was done with a modified Waring blendor by Mr. Myron Grennell of the USDA Seed Research Laboratory, Oklahoma A. & M. College. Seed from border areas was harvested by heading with a binder and subsequent threshing of cut material through a combine. Forage yield samples were taken in late December 1955 of the stubble left from this harvest.

Results

The part of the field watered through the first half of the season in 1953 failed to head out in the fall, while the area which had no irrigation and had been virtually dormant headed out profusely with late July and August rains. Seed yields and caryopsis percentages were very low. Plots which had been sprayed with dieldrin had a significantly higher caryopsis percentage than did the check plots or those sprayed with systox or parathion. Results of spray treatments are given in Table 1. In 1954 dieldrin again gave a significant increase in seed set. Caryopsis percentages from all treatments were considerably better in that year, and were even higher in 1955. The slightly increased set from dieldrin was not significant in 1955. Fifty pounds of nitrogen per acre gave significantly higher seed sets in 1954 under all treatments than did the checks. Average caryopsis percentage was 30.9 on the fertilized plots and 20.9 on the unfertilized plots.

Rough seed yields were not measured in 1953 and were not significantly affected by spray treatments in either 1954 or 1955. Average rough seed yield in 1954 from the check plots was 81 pounds per

Table 1. Caryopsis percentages in rough seed harvested from blue grama sprayed with various insecticides.

	Treatment*				
Year	Dieldrin	Parathion	Check	Systox	DDT
1953	3.4	2.2	1.9	1.9	—
1954	30.7	27.3	24.0	—	—
1955	36.7	—	34.7	—	34.7

* In any row of figures those means which do not have a common line underscoring them differ significantly at the 5% level. Figures for 1953 are averages of four entries, 1954 and 1955 data of 16 entries with two samples each.

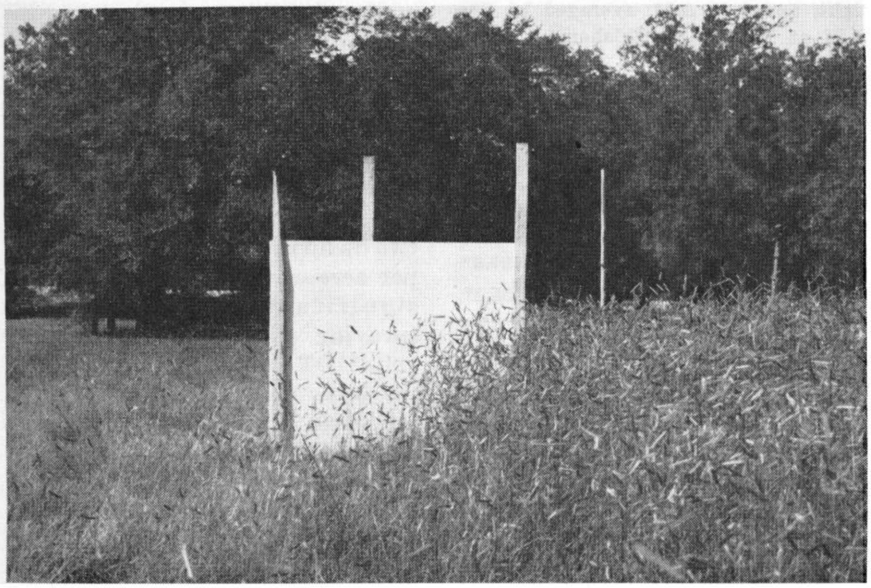

FIGURE 1. Blue grama seed production test in 1955. Area at right was fertilized, at left not. Both received equivalent irrigation. The board is 30 inches high.

acre while on the fertilized plots it was 326, a fourfold increase from the application of nitrogen. In 1955 there were no significant differences in either rough seed or clean grain yield among the various fertilizer treatments nor were there any measurable residual effects from applications made in 1954. Average rough seed yield per acre was 405 pounds. Figure 1 shows the difference between a fertilized plot and its unfertilized border in 1955.

Clean grain or caryopsis yields per acre calculated from 1954 data were 101 pounds from fertilized plots and 20 pounds from the checks. On fertilized plots, dieldrin spraying increased caryopsis yield 18 pounds per acre. On unfertilized checks the increased caryopsis yield from spraying with dieldrin was 7 pounds per acre. These figures are based on average rough seed yields and caryopsis percentages from the treatments in question. In 1955 the calculated caryopsis yield per acre was 143 pounds, with no significant differences among treatments.

Forage yields in 1954 and 1955 are shown in Table 2. Fifty pounds of nitrogen per acre more than doubled total yield in 1954, and an evident similar effect in 1955 is shown by figure 1.

Discussion

On a soil low in nitrogen and organic matter, 50 pounds of nitrogen per acre plus an adequate moisture level during a six week period was sufficient to produce a good seed crop in 1954 and again in 1955. A very rough estimation of the amount of irrigation water used in 1955 would be 14 inches. No record was kept in 1954, but the soil was kept moist. Natural rainfall was 0.90 inches in 1954 and 2.18 inches in 1955 during the period August 15 to September 30. In 1953 over 8 inches of rain fell in July and August but only .32 in September, probably explaining the large amount of bloom but low seed set. Annual rainfall was 86.4 percent in 1953, 55.0 percent in 1954, and 71.4 percent in 1955 of respective "normals" calculated from data reaching back to 1885.

Timing of bloom so that flowering occurs in September seems as essential at Woodward as adequate moisture and fertility levels. This is in agreement with published observations (Hoover, et al., 1947, Wolff 1951, and Riegel 1940). The author, in another study, noted that blue grama flowering during a period of high temperatures (maximums around 105° for several days) had a very high percentage of aborted pollen. This occurred while soil moisture was being held at high levels by irrigation. Blue grama flowers early in the morning. Jones and Newell (1946) found that the peak pollen shed was between 4:50 and 5:50 a.m. at Lincoln, Nebraska. This is usually the coolest part of the day at Woodward. Table 3 gives the average temperatures at Woodward by ten-day periods at 6:00 p.m., midnight, and 6:00 a.m. for the period 1945-54. It may be seen that at about the date anthesis began in the 1954 and 1955 experiments (1st half Sept.) a sudden drop in average night temperatures ordinarily occurs. Blooming continued through the month of September. Jones and Newell (1946) stated that temperatures below 60° inhibited blooming and pollen shed at Lincoln. Night temperatures this low are not common at Woodward until October.

The most common insects associated with the blooming blue grama appeared to be thrips and leaf hoppers. Thrips were observed within

Table 2. Pounds air-dry forage per acre produced by blue grama irrigated and fertilized in mid-August with irrigation continued through September.

	Treatment*				
	No nitrogen	50 lb. N/acre	100 lb. N/acre	200 lb N/acre	400 lb. N/acre
1954 Total seed and forage	1,561	3,648	——	——	——
1955 Total seed and forage	——	4,005	3,763	4,177	4,562
1955 After seed harvest (Dec.)	——	2,348	2,348	2,396	2,638

* In any row of figures those means which do not have a common line underscoring them differ significantly at the 5% level. Figures for 1954 are averages of eight entries. Data in 1955 are averaged from four entries each.

Table 3. Temperatures at 6:00 P.M., Midnight, and 6:00 A.M. averaged by ten-day periods for the ten years 1945-54 at Woodward, Oklahoma.

Period	6:00 P.M.	12:00 P.M.	6:00 A.M.	Period	6:00 P.M.	12:00 P.M.	6:00 A.M.
June 14-23	87.5°	73.9°	69.9°	Aug. 13-22	89.4°	76.1°	70.8°
June 24-July 3	86.8°	74.4°	71.5°	Aug. 23-Sept. 1	85.4°	74.2°	70.3°
July 4-13	86.6°	74.4°	71.5°	Sept. 2-11	84.1°	70.4°	65.7°
July 14-23	90.5°	77.1°	72.1°	Sept. 12-21	79.1°	66.9°	62.1°
July 24-Aug. 2	90.8°	77.2°	72.5°	Sept. 22-Oct. 1	74.3°	62.6°	57.8°
Aug. 3-12	89.1°	76.3°	71.9°	Oct. 2-11	70.7°	59.9°	55.1°

the florets at all stages of development. Larvae of the gall midge family were also found. Control of the above insects was by no means complete on sprayed plots since many were observed throughout the experiments, but the higher caryopsis percentages obtained on dieldrin sprayed plots indicate the possibilities from insect control. Infestation by insects was apparently less in 1955 than in 1954, probably explaining, along with slightly cooler temperatures and higher humidity, the higher seed sets.

The relatively high total production of seed and forage over the short period from mid-August means an appreciable potential income from the forage produced. Combine residues and stubble remaining after seed harvest would have fairly high feeding value and provide considerable forage. In addition, there would be grazing through the fore part of the summer. In 1955 there was sufficient growth to clip the area twice with a hay mower. Although not enough for a worthwhile hay crop, this would have furnished considerable grazing.

The implications of these results apply to other native grasses as well as blue grama. They are fourfold. First is the need for adequate moisture and fertility levels. Second is the need for those levels at the right time—manipulation of blooming period to fit climate; harmonizing management with growth cycles. Third is the often overlooked fact that seed production fields can also produce usable forage and an appreciable extra income from that forage over and above the seed. Fourth is the possibility that much of the low seed set found in native grasses may be due to insect pests. Appreciable increases in seed quality and seed production might be attainable with chemical controls. Highest incomes from seed production and most consistent results will probably not be attained unless these implications are taken into account.

Summary

Seed production studies were made in 1953, 1954, and 1955 on an established stand of blue grama drilled in 12-inch rows at the United States Southern Great Plains Field Station, Woodward, Oklahoma.

Excellent heading and seed set were obtained in 1954 and 1955 by applying water and ammonium nitrate fertilizer to summer dormant grass in mid-August, with continued irrigation until seed was in the soft dough stage.

In 1954, plots to which 50 pounds of nitrogen per acre were applied, produced 326 pounds of rough seed per acre while checks yielded 81 pounds. Fertilized plots had more heads and higher caryopsis percentages.

In 1955, rates of 50, 100, 200, and 400 pounds of nitrogen per acre were used with no check other than observation of adjacent untreated areas. There were no significant differences in seed yield, caryopsis percentage, or forage yield among the four rates and no residual effects on these characters from the 50 pound application in 1954. Average rough seed yield was 405 pounds per acre.

Significant increases in caryopsis percentage were obtained in 1953 and 1954 from dieldrin applied at 0.25 pound per acre, with total applications .25 pound in 1953 and .50 pound in 1954. Insect infestation in 1955 was apparently low and the increase in seed set from two dieldrin sprayings at .25 pound per acre each was not statistically significant. In these studies, spraying with systox, parathion, and DDT had little effect upon caryopsis percentage. Increases in caryopsis percentages were probably primarily due to control of thrips.

A considerable amount of valuable forage was produced each year in addition to the seed. Total air-dry yields of seed and forage on fertilized plots averaged 3,648 pounds per acre in 1954 and 4,127 pounds in 1955. Air-dry forage available for grazing after seed harvest in 1955 averaged 2,432 pounds per acre.

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