

The Production of

Southland Smooth

Bromegrass Seed

***Bromus inermis* Leyss.**

in Oklahoma

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The Production of Southland Smooth Bromegrass *Bromus inermis* Leyss. Seed in Oklahoma

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Southland smooth bromegrass, *Bromus inermis* Leyss., is well adapted to the climatic conditions in Oklahoma and was recommended and released by the Oklahoma Agricultural Experiment Station in 1953.

Attempts to encourage growers to produce seed under the certification program met with some success for several years. Now, however, no certified or registered seed is produced in the state due to insufficient information regarding the best cultural and management practices for seed production. Low yields and especially infestation of annual bromes in fields devoted to seed production have discouraged growers.

Research reported herein was made to determine the effects of various fertilizer treatments on Southland smooth bromegrass seed yields; to determine the effects of solar radiation, soil and air temperature, moisture, fertility and minute insects on the seed set of Southland smooth brome-grass.

Literature Review

Seed yields from new bromegrass stands are usually high the first and second crop years but decrease rapidly with age. Part of the problem is inadequate fertility, especially nitrogen, and water. Fertility studies in Kansas, Anderson (1) and Nebraska, Newell and Keim (10) showed similar results. Seed and forage yields increased with increasing amounts of nitrogen up to 100 pounds per acre. Nitrogen applied in the fall

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stimulated seed yields as effectively as early spring applications. Ammonium nitrate, ammonium sulfate, and calcium nitrate are all effective suppliers of nitrogen for brome grass according to Harrison and Crawford (8), Churchill (4) and Laughlin (9). Seed yields varied from 750 to 1,000 pounds per acre (1) and to as much as 1,100 pounds per acre in fertility studies conducted by Cain, *et al.* (2). Chessmore and Harlan (3) reported that 100 to 500 pounds of seed per acre may be obtained with fertilization in Oklahoma.

Helminthosporium leaf spot and bacterial blight are common diseases of brome grass in Oklahoma. Tamini and Dunn (12), Drolsom and Kaufmann (7) and Thomason and Dickson (13) have evaluated the reaction of brome grass to various diseases.

A differential exists in thermal death points of the staminate and pistillate organs of smooth brome grass. This differential was evident in studies conducted by Domingo (6) when he used hot water to emasculate smooth brome grass florets. Panicles treated at 47°C. for five minutes remained capable of seed production by wind pollination, but were effectively emasculated when compared to the production of selfed seeds. Clark (5) confirmed these findings and showed that proper temperature of hot water varied with the time of day. A 45°C. treatment before 10 a.m. and after 5 p.m. was as severe as a treatment of 47°C. during the warmest part of the day.

Partial-to-complete blasting of the seed head is not uncommon in grasses in Oklahoma. Starks and Thurston (11) refer to the blasted seed head of bluegrass as silver top. They found that the larvae of several insects *Oscinella neocoxendix* and *O. coxendix* (Chloropidae) were associated with this abnormality.

Methods and Material

Approximately one-quarter acre of Southland smooth brome grass was established in three foot rows under irrigation in the fall of 1955. Management studies were initiated in 1956. The study utilized 13 fertility treatments: (1) check; spring treatments; (2) 40 lbs. N per acre; (3) 80 lbs. N per acre; (4) 160 lbs. N per acre; (5) 320 lbs. N per acre. Treatments 6, 7, 8, and 9 were the same as treatments 2, 3, 4, and 5 but applied in the fall. Four fall and spring split applications were made: (10) 20 + 20 lbs. N per acre; (11) 40 + 40 lbs. N per acre; (12) 80 + 80 lbs. N per acre; and (13) 160 + 160 lbs. N per acre. Three replicates of each treatment were utilized in a randomized block design. Each repli-

cate contained three 25-foot rows. Yields were taken from the middle row of each plot. Seed yields by treatment were threshed, cleaned and reported in pounds pure seed per acre.

Although seed yields were reasonably high during 1957 and 1958, many empty florets per spike were observed. The potential crop response to treatment was not fully realized due to the partial blasting of the seed heads. Solar radiation, soil and air temperature, moisture, fertility, and minute insects were investigated as factors affecting seed set.

A white horizontal canopy (made of 45° angled louvers, 10 by 10 feet), mounted on adjustable legs and built to allow free air movement, was placed over the plants under field conditions prior to blooming. Solar radiation and air temperature measurements were taken at five locations (east, west, north, south, and center) under the canopy and at one reference location under open field conditions from heading to maturity. A measure of solar radiation was obtained with a black-bulb thermometer enclosed in an evacuated glass envelope. The readings were considered proportional to the intensity of solar radiation received among the seed heads. Similar white-bulb enclosed thermometer measurements were taken at the outside location. Daily readings were taken at approximately 2-hour intervals from 8 a.m. until 6 p.m.

The effect of the varying radiation received among the seed heads under the canopy was measured by harvesting five spikes from each location at weekly intervals. The number of florets produced per spike and number of pure seed found at each interval were recorded. An attempt was made to relate the intensity of solar radiation incident upon the seed heads beneath the canopy to seed set.

The effect on seed production of dieldrin applied at 0.44 pounds active ingredient per acre for insect control was studied in combination with fertility in 1961, '62, and '63. Spray applications were applied to one-half of each fertilized plot during the boot stage and again a week after full bloom.

A preliminary survey of insects was conducted during the reproductive stage to determine the kinds of possible seed-feeding insects responsible for seed loss. A thin layer of Tree-Tanglefoot (containing castor oil, natural gum resins, and vegetable wax) was spread on an 8 by 10 inch sheet of paper suspended on a wooden stake in the field. Two collection sites, one at head height and the other at the basal leaf area of the plants, were used. The trapped insects were removed at regular intervals from the adhesive material with ethyl alcohol.

Results and Discussion

Seed yields in 1957 were significantly different between rates of nitrogen fertilizer (Table 1) but not between dates of application. Regardless of whether treatments were applied in the fall, spring, or split fall and spring, 80 pounds actual N per acre produced the highest yields. Seed yields in 1958 were not significantly different between rates and dates of application nor between rate x times x dates. Unfertilized check plots produced higher average yields than the fertilized plots. During both years, 160 and 320 pounds N per acre produced the least amount of seed regardless of whether treatments were applied in one application, fall or spring, or split fall and spring.

Bromegrass appeared to be sensitive to climatic conditions during seed development and maturity. Potential increases from fertilization were nullified by seed blasting.

The percentage of blasted florets per spike in smooth bromegrass was highest during years with high daytime temperatures. Poor seed set

Table 1. Average of three replications in pounds pure seed produced by treatment and date of application, 1957-58.

Time of Application	Actual N. Per Acre	Pounds per acre	
		1957	1958
Fall	0	603	628
	40	512	365
	80	672*	349
	160	545	282
	320	499	294
Spring	40	590	404
	80	662*	356
	160	481	274
	320	363	264
Split Fall and Spring	20 + 20	635*	382
	40 + 40	635*	485
	80 + 80	558	319
	160 + 160	408	235

*Significant at the 5% level of confidence.

percentages between years were thought to be caused by an interaction between day length, humidity, hot dry winds, high solar and nocturnal radiation and/or conductivity of the seed appendages, soil temperature, soil moisture, and fertility.

The effects of varying amounts of solar radiation on seed set were investigated in 1959 and '60. Solar radiation, using black-bulb and air-temperature thermometers, was measured from the time of heading to seed maturity at nine locations under a louvered canopy.

Air temperatures simultaneously observed at the nine locations under the canopy were within 1°C. from location to location during both years. Average air temperatures beneath the canopy and with those observed under field conditions also were within 1°C. Soil temperatures were in closer agreement than those of air temperatures. The uniformity of both air and soil temperature from location to location was inconsistent with the variation found in the number of florets per spike, the number of seed units per spike, and the percentage of blasted florets (Table 2). This suggested that air and soil temperature played a minor role in seed-blasting.

Table 2. Effect of varying amounts of solar radiation on the production of smooth bromegrass seed.

	Year	Canopy Sample Location					
		East	West	North	South	Center	Outside
Av. Number florets per spike	1959	169	187	110	114	107	224
	1960	282	177	153	173	109	271
Av. Number pure seed found per spike	1959	39	55	71	73	64	42
	1960	126	47	23	33	68	81
Percent of Total seed-set	1959	23.5	34.5	70.5	78.3	65.2	21.9
	1960	43.8	26.5	15.0	19.1	40.2	29.8
Percent of total potential lost (blasted seed)	1959	76.5	65.7	29.5	21.7	34.8	78.1
	1960	56.2	73.5	85.0	80.9	59.8	70.2

Table 3. Average daily black-bulb temperatures °C. and time of maximums at various locations under a canopy as compared to open field conditions, 1959-60.

	Year	East	West	North	South	Center	Outside
Av. daily (8 a.m. to 6 p.m.) radiation	1959	36.3	38.1	33.7	34.6	32.5	41.9
temp. °C.	1960	36.4	36.6	36.0	37.1	32.0	41.0
Time of maximum average temp.	1959	10am	4pm	2pm	2pm	2pm	2pm
°C.	1960	10am	4pm	4pm	4pm	2pm	2pm
Av. temperature °C. at the above time	1959	40.3	46.1	35.5	38.1	35.0	45.7
	1960	39.8	44.2	36.8	43.8	36.3	44.7
Av. temperature °C. below outside	1959	5.4	-0.4	10.2	7.6	10.7	0.0
	1960	4.9	1.5	7.9	.9	8.4	0.0

The average number of florets produced, as compared to the average temperatures, Table 3, was directly proportional to the intensity of radiation. The subsequent fate of these seeds was not clear-cut due to the wide variability of insect damage from location to location (Figure 1). The insect was identified as belonging to the Chalcid group. The figures indicated that the insect had a preference for the locations with the greatest amount of radiation but these were inconclusive.

The variation due to insect damage was eliminated by assuming that insects damage seed indiscriminately. Thus, the total counts of florets were reduced by an amount equal to the quantity of damaged seed and the percentages of blasted and pure-seed were recomputed.

The three locations with the highest daily average black-bulb temperatures showed about twice the percentage of blasting in 1960 as the three more shaded locations. The outside location had the highest percentage of seed blasting as well as the largest number of florets per spike. However, the seed heads sampled in the east area under the canopy had over 10 percent more blasting than those in the west. This was in con-



Figure 1. Seed damage due to an insect identified as belonging to the *Chalcid* group in 1960. The larvae of *Oscinella* spp. are also suspected as seed feeders of smooth brome.

trast to observations that the west had both a higher average daily and a higher average maximum black-bulb temperature. The only apparent explanation for the greater percentage of blasting in the east location was that it received a maximum intensity of radiation in the morning when air temperatures were low and dew was frequently on the plants. The following year, however, blasted seed found in the east section of the canopy was 25 to 30 percent less than the amounts found in the west and south.

The humidity in the plant environment is affected by air movement and radiant energy. The lack of air movement and increasing radiant energy may affect stigma receptability or the dispersal and longevity of viable pollen.

The data strongly indicate that excessive solar radiation increases the number of florets per spike, but drastically decreases the percentage of seed set. Thus, intense solar radiation appears to decrease seed yield.

From these studies it was apparent that minute insects cause considerable damage to seed set and, subsequently, yield in smooth brome-grass. The gradual development and lack of uniform maturity characteristic of most native and introduced grasses provide an ideal habitat where populations of very small insects may expand, unnoticed, into surprising proportions.

Table 4 shows the kinds of insects which inhabited the smooth brome-grass seed production area. A greater number of species possibly could have been collected. Although some are known to be parasites on other insects, many are suspected seed feeders and need to be positively identified. In general, the influence of insects in grass seed production remains largely unknown.

Table 4. A preliminary survey of minute insects found among smooth brome-grass plants from boot stage to plant maturity.*

Order	Family	Genus and Species
Diptera	Cecidomyiidae	(unidentified) 2 different specimens
	Ceratopogonidae	Forcipomyia brevipennis (Macq.) Dasyhelea sp.
	Chironomidae	(specimen lost)
	Chloropidae	Oscinella sp.
		Siphonella sp.
		Oscinella coxendix
		Hippelates plebejus (lw.)
		Thaumatomyia glabra (Mq.)
		Oscinella minor (Adams)
		Elachiptera (melanochoeta) kaw Sabr.
	Phoridae	Genus and Species (unknown)
	Sarcophagidae	Sarcophaga sp.
		Sarcophaga (Helicobia) rapax (Walk.)
	Simuliidae	Simulium meridionale (Riley)
	Sciaridae	Bradysia sp.
	Syrphidae	Platycheirus sp.
Coleoptera	Dermeestidae	Trogoderma glabrum (Hbst.)

Table 4. (Cont'd.) A preliminary survey of minute insects found among smooth bromegrass plants from boot stage to plant maturity.

Order	Family	Genus and Species
Collembola	Entomobryidae	Drepanocyrtus bipunctatus (Packard)
Hemiptera	Lygaeidae	Phlegyas annulicrus (Stal.)
	Miridae	Lygus lineolaris (Beauvois)
	Nabidae	Nabis alternatus (Parshley)
Homoptera	Aphidae	Rhopalosiphum rufiabdominalis (Sasaki)
	Cicadellidae	Deltocephalinae sp. Cicadellinae sp. Xestocephalus pulicaris (Van D.) Athysanella sp.
	Delphacidae	Delphacodes campestris (Van D.)
Hymenoptera	Encyrtidae	Mirini sp.
	Eulophidae	Tetrastichus sp.
	Halictidae	Lasioglossum (Evylaeus) sp.
	Ichneumonidae	Campoletis sp.
	Pteromalidae	Amblymerus sp.
	Trichogrammatidae	Aphelinoidea plutella (Girault)
Neuroptera	Chrysopidae	Chrysopa carnea (Steph.)
Thysandptera	Thripidae	Frankinella occidentalis (Pergande)

*Insect specimens were identified by the Insect Identification and Parasite Introduction Research Branch, Entomology Research Division, Agricultural Research Service, U. S. Department of Agriculture.

Indications were that an insect belonging to the *Chalcid* group accounted for an approximate 30 percent decrease in the amount of pure seed produced in 1960. Spray applications of dieldrin during the boot stage of reproduction and again a week after blooming increased the amount of well filled pure seed two out of the three years studied (Table 5).

At the start of the fertility-insecticide studies in 1960, two to three pounds per acre simazine were applied each spring to control annual brome. The continued use of simazine reduced seed production and

Table 5. Effect of fertilizer with and without spray applications of dieldrin on Southland smooth brome grass yields, 1961-63.

Dieldrin									
Treatment	With			Without			Difference		
Lbs. N/Acre	1961	1962	1963	1961	1962	1963	1961	1962	1963
Pounds pure seed per acre									
0	283	286	73	234	267	34	29	21	29
40	290	331	50	262	201	69	28	130	—19
80	262	275	58	203	106	87	59	89	1
120	422	191	80	248	241	76	174	—50	4

caused a gradual and early drying of the lower plant leaves. After three consecutive yearly applications, some areas 20 to 30 feet long within a row were completely void of plants. A small test in 1963 using active simazine applied at three, six and eight pounds per acre confirmed the herbicide effect on production and stand maintenance. Without exception the injury, gradual dying, and failure to set seed was the same as that observed earlier.

The extent to which microclimatic conditions influence the physiological factors of seed development are not well understood. The problem in production studies is no longer how much water and nutrients are required for maximum production but the lack of realizing full seed set possible under optimum fertility and moisture regimes. Failure to realize full seed set potential, in the presence of adequate fertility and soil moisture is evident in a large number of both native and introduced grasses as well as most other crops.

Summary

Fertility and management studies on smooth brome grass showed that seed production is increased by up to 80 pounds actual nitrogen per acre regardless of whether treatments are applied in fall, early spring, or split fall and early spring. Heavier rates of nitrogen appeared to reduce seed yields in favor of forage. Phosphorus in combination with nitrogen was of little value in stimulating seed production.

Throughout the study, potential increases in seed produced by fertilization were nullified by blasting, to the extent of 50 to 70 percent of the exposed florets. The percentages of blasted florets per spike were highest during years with high daytime temperatures.

Preliminary investigations regarding the cause of seed blasting indicated that during reproduction smooth brome-grass requires a certain amount of diffused radiation for maximum seed set. The data indicated that the average number of florets produced per spike was directly proportional to the intensity of radiation. Whereas, seed set was reduced under continued high solar radiation.

The uniformity of both air and soil temperatures under a canopy was inconsistent with the variation found in the number of florets, the number of pure seed produced, and the percentage of blasted florets per spike. This inconsistency indicated that air and soil temperatures play a minor role in seed blasting.

Part of the cause of seed blasting and low yields was attributed to minute seed feeding insects. An insect belonging to the *Chalcid* group accounted for approximately a 30 percent decrease in seed set in 1960. Spray applications of dieldrin applied once during the boot and blooming stage of reproduction increased seed yields in two out of three years studied.

A survey on the kinds of insects inhabiting the seed production area revealed a number of suspected feeders. However, little is known about the life cycles, feeding and other habits of most of the species collected. Certain of these suspected feeders need to be positively identified and a means of control developed. The influence of the minute insect in grass-seed production remains largely unknown.

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Oklahoma's Wealth in Agriculture

Agriculture is Oklahoma's number one industry. It has more capital invested and employs more people than any other industry in the state. Farms and ranches alone represent a capital investment of four billion dollars—three billion in land and buildings, one-half billion in machinery and one-half billion in livestock.

Farm income currently amounts to more than \$700,000,000 annually. The value added by manufacture of farm products adds another \$130,000,000 annually.

Some 175,000 Oklahomans manage and operate its nearly 100,000 farms and ranches. Another 14,000 workers are required to keep farmers supplied with production items. Approximately 300,000 full-time employees are engaged by the firms that market and process Oklahoma farm products.