Establishment and Management of Old World Bluestem Grasses for Seed

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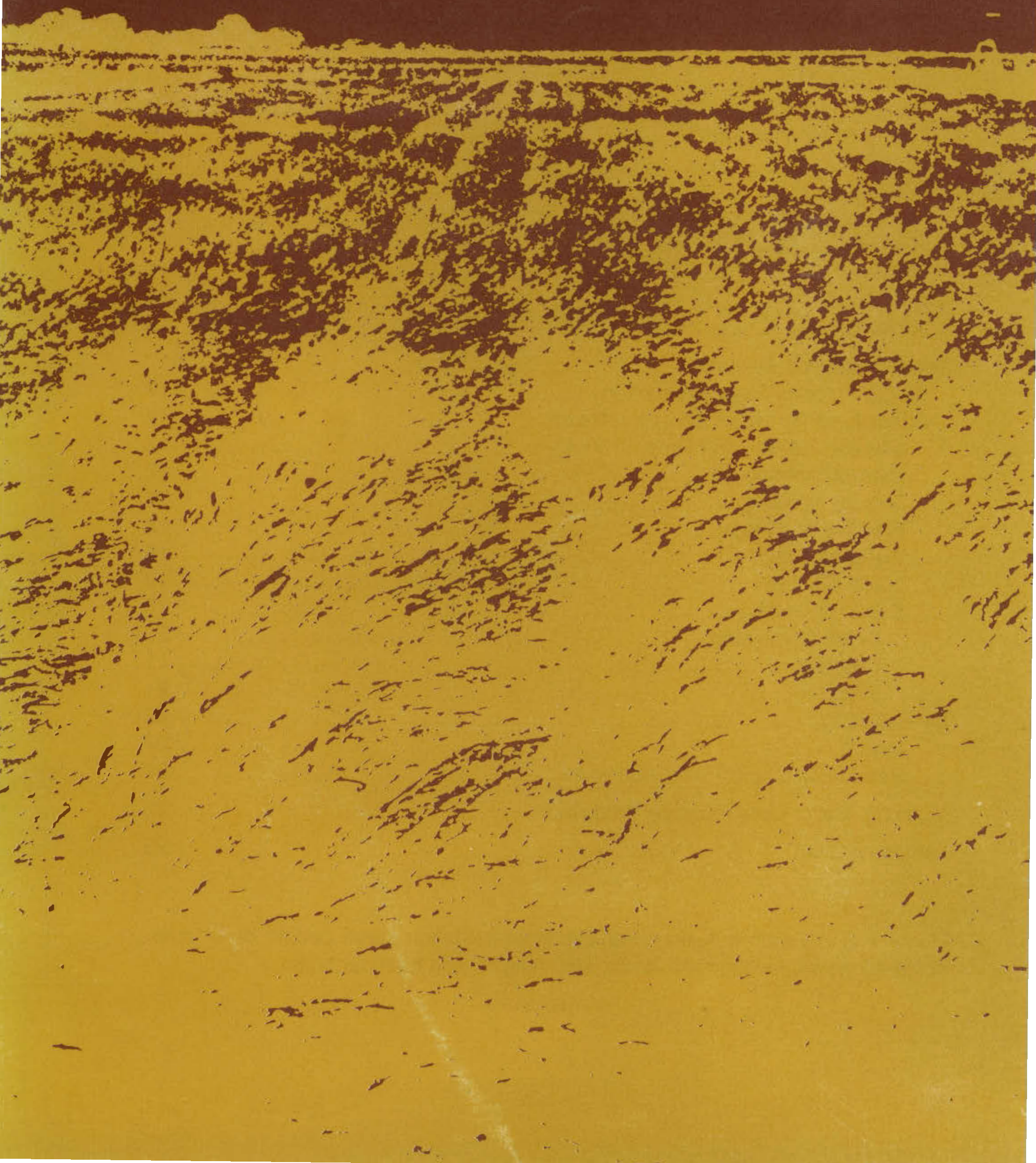

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Establishment and Management of Old World Bluestem Grasses for Seed[1]

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INTRODUCTION

Maximizing grass seed production is largely a matter of agronomic technique. The quantity of seed produced per unit area, as influenced by management or cultural practices is due to changes in density of seedheads and number of seeds set per head. In grasses, head numbers per unit area, aside from seed-set, varies considerably and are influenced significantly by stand density (5, 6, 11), nitrogen (4, 5, 6, 10), mowing (4, 21, 22), year (4, 6), strain (4) and age of stand. Problem areas for maximum production are numerous; many center around the causes of variation in seed yield due to environment and management, e. g., row spacing (5, 6, 11, 12), date of fertilizer application (5, 10), moisture (20), etc. In some cases diseases and insects (2, 14) can be incriminated; in others, parasitic nematodes and root fungi may be involved.

With many grass species, especially those having chaffy seed units, seed production potential is high but harvesting efficiency very low. In the "Asiatic" or Old World bluestems seedstalk production is continuous (3) and seedhead populations change numerically and in quality, seed-set/inflorescence, with time. Thus, at harvest early heads have shattered and late heads are immature and do not contribute to seed yield.

Although the results of numerous seed production studies on grasses have been published, only one has been found to involve an Old World bluestem (3). Harvested seed yields of these grasses, i.e., 'King Ranch' [*Bothriochloa ischaemum* var. *songarica* (Rupr. ex Fisch. & Mey) Celar. & Harlan]; 'El Kan' [*B. ischaemum* (L.) Keng var. *ischaemum*]; 'Caucasian' [*Bothriochloa caucasica* (Trin.) C. E. Hubb]; 'Medio' [*Dichanthium papillosum* (Hochst. ex A. Rich) Stapf.]; etc., are notoriously poor and have been a factor in limiting their widespread use.

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Research data and observations of soil conservation specialists and range and forage scientists indicate that the Old World bluestem grasses, in addition to improved native grass strains, have the greatest potential to increase production and carrying capacity of our rangelands. Interest in these grasses has been aroused because of their apparent superiority to the American bluestems in production, persistence under grazing and response to high fertility levels and the fact they are relatives of our native bluestems. It is estimated that 20 to 40 million acres eventually will be established to Old World Bluestem grasses if seed becomes available in the Southern Great Plains area.

Several new bluestem grass strains derived from the Old World bluestem breeding program (7, 17, 19) of the 1960's at the Oklahoma Agricultural Experiment Station are in various stages of range and pasture evaluation. Some of these strains are composites of similar apomitic ecotypes. Therefore, plant ecotype composition of strains may change with each advancing generation. Supporting evidence for this statement is that two years of data on seed-set/infloresence in four of the 30 ecotypes comprising the variety 'Plains' ranged from 3 to 28 percent. The composition of the seed produced will shift to those ecotypes best adapted to existing environmental conditions and to those that consistently set seed well. By advancing seed production beyond the carefully controlled original strain, the true identity of the original material and potential for obtaining plants adapted to a different set(s) of environmental conditions are lost. Good seed production from an original strain(s) of this nature and from established stands across a wide range of conditions is essential.

A description of three Old World bluestem grasses, 'Plains', *Bothriochloa ischaemum* var. *ischaemum*, Caucasian, and an experimental strain referred to as "T", *B. intermedia* (R. Br.) A. Camus, (19) along with a series of seed production experiments carried out on each are given on the following pages. Emphasis is placed on the relationship of cultural conditions to seed yield, particularly the effect of nitrogen fertilization. A knowledge of the effects of nitrogen fertilization and management should contribute to improved grower techniques, resulting in increased yields of high quality seed.

DESCRIPTION

Plains Bluestem

Plains bluestem is a vigorous, drought-tolerant winter-hardy strain of the *ischaemum* complex of the Old World (Asiatic) bluestems. This new forage species, developed at the Oklahoma Agricultural Experiment Station, is a composite of 30 morphologically similar selections made by J. R. Harlan in 1963 (19) from plant materials introduced from Turkey, Iraq, Russia, Af-

Figure 1. Plains bluestem established in 36 inch (91 cm) rows for seed production, El Reno, Oklahoma. This variety under irrigation and managed properly will produce from 100 to 300 pounds seed per acre (112 to 336 kg/ha).

ghanistan, Pakistan, and India. It was tested and evaluated under the experimental designation "M-Blend."

Plains bluestem differs from the El Kan and King Ranch varieties of Old World bluestem primarily in growth habit, plant size and forage production. The El Kan and King Ranch varieties are small, leafy, less productive varieties of the same taxonomic grouping as Plains. El Kan is grown mainly in Kansas but does not do well in Oklahoma. King Ranch bluestem is grown from central Oklahoma southward due to its lack of cold hardiness in more northern areas. Plains has a more upright growth habit than the prostrate King Ranch and is resistant to rust organisms that often severely damage the latter variety. Plains has been more productive than King Ranch in Oklahoma Agricultural Experiment Station tests. Evidence at hand suggests that it will tolerate a wide range of soils.

Although no experimental plantings have been made on strongly alkaline soils, performance on acid soils typical of the eastern part of the state, Muskogee, and on neutral-to-slightly alkaline, medium and fine textured soils of central, Stillwater, El Reno, Chickasha and western, Mangum, Cherokee, Oklahoma have been encouraging. The variety is winter-hardy throughout the state and will persist under conditions of moisture stress. The area of major use will probably be in the western one-half of Oklahoma and Texas. The grass has potential in the southwestern and eastern areas of Kansas, parts of Missouri, Arkansas and Illinois in addition to eastern New Mexico and Colorado. In south-central Oklahoma it is being used in preference to bermudagrass. Research results there (8) indicate that under the fertility regimes producers use, Plains will perform better than bermudagrass. In this regard, just how far east and southeast the species will find acceptance is unknown.

Plains bluestem begins growth slightly later in the spring than native grasses but similar to Midland and Coastal bermudagrass. Under conditions of adequate fertility and good moisture, it is capable of very high forage production throughout the growing season. On dryland, Plains may be grazed from May through late fall. The late summer decline of forage quality in both native and tame bermuda pastures reduces livestock gain and net income potential from some grazing systems. Plains bluestem will fit into many integrated forage systems with weeping lovegrass, bermudagrass, fescue, native grass, etc., and may be useful in extending the quality forage calendar of our present pasture systems in some areas, if managed properly, well into late summer and fall.

Caucasian Bluestem

Caucasian bluestem, was introduced (13, 15) from Russia in 1929, and released by the Soil Conservation Service, USDA in 1946 as a promising forage grass for the central Great Plains area. It is sometimes less palatable to livestock than other Old World bluestem species and that of our better native

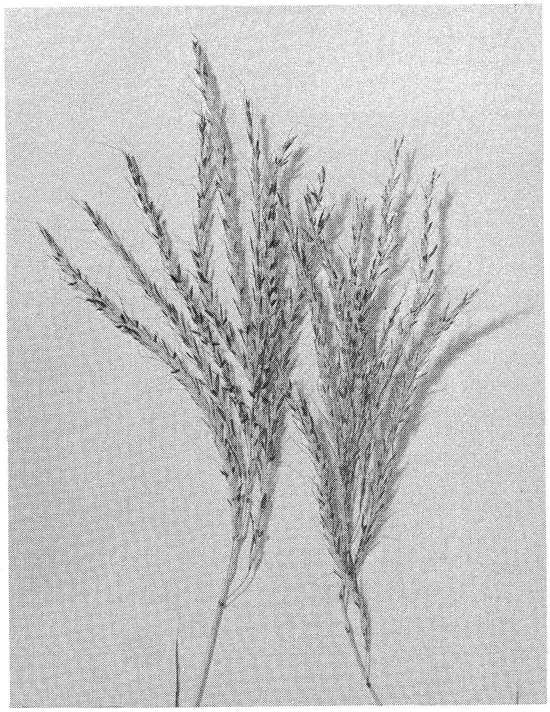

Figure 1-b. T-Strain.

grasses, but when grazed in pure stands and properly managed, will produce excellent daily gains. Caucasian produces an abundance of forage on a wide variety of soil types. Similar to Plains, it does best on fertile fine textured soils and responds well to nitrogen fertilization.

Caucasian begins growth in April, earlier than Plains. If ungrazed or unmowed it will produce a mature seed crop in late June or early July. As with most grasses forage quality decreases with maturity. It is drought-tolerant and winter-hardy throughout Oklahoma, free of diseases and spreads well from seed.

Inadequate seed supplies, reports of unpalatability, and cost of the seed are the major reasons this grass has not been widely used.

T-Strain Bluestem

Several *Bothriochloa intermedia* strains are being evaluated under experimental designations of "T", "L", "LL", "B", "H", "I", "J", and "K." Each strain is a mixture of two to 31 like or very similar lines. The T-strain is a composite of two probably duplicate accessions of different origin. The lines comprising these strains are predominately from India and Pakistan. These strains, especially the *indica* types (9, 17) initiate growth later in the spring than either Caucasian or Plains bluestem and some are pungent and high in aromatic oils. The pungence of these strains does not prevent their utilization by livestock.

As a group, *intermedia's* are not as drought-tolerant nor as winter-hardy as *ischaemums* and are better adapted to the more humid areas.

STAND ESTABLISHMENT

Requirements

Stands of these grasses established exclusively for seed production should be on locations where the soil is fertile and irrigation water is available if needed. For quick and uniform emergence of all three species, planting should be delayed until the soil is warm, in late May to June 21. Planting earlier than late May is more important under dryland conditions in order to take advantage of early summer rainfall. Unpublished data on seeding dates and rates of planting seed under dryland conditions from studies conducted on the Oklahoma Agricultural Experiment Station at Perkins, Oklahoma, show that excellent stands can be obtained (with adequate rainfall) by planting as late as July 15 without subsequent winter injury (Table 1). However, seed should be planted on or about June 1 for best results. The later planting date eliminates many weeds and weedy grasses that compete with young seedlings. For range and pasture establishment, earlier planting dates are desirable.

Figure 1-c. Caucasian Bluestem Early Heading.

Table 1. The effect of seeding rates and dates on the establishment of Plains bluestem in 36 inch (91 cm) rows.

Rate Pure-live-seed* Pounds/Acre	Calculated or expected number of seedling/acre	No. of seedlings per acre observed		
		Planting Date		
		June 15	July 15	Stand-Cond.
½	239,390	163,430	159,720	Excellent
1	478,779	286,044	217,800	Excellent
2	957,558	486,420	410,220	Excellent

*Actual live, germinable seeds, firm seeds were not included as a part of the P.L.S. content.
To convert pounds/acre to kg/ha multiply by 1.121
To convert number of seedling/acre to number of seedling/ha multiply by 2.471

Seeding Rates

Seeding rate is dependent on row spacing and quality of seed. A pound (0.45 kg) of pure seed of Caucasian, T-strain, and Plains bluestem will contain approximately 1,000,000 (18), 1,072,000 (18), and 478,779 (1) chaffy seed units, respectively. On a live seed basis if conditions for germination, seedling emergence and survival are met, a one pound per acre rate (1.12 kg/ha) will produce excellent stands. Usually the number of pure seeds in a fixed weight will vary with year due to climatic conditions during seed set and fill under field conditions. Seed production fields should be established in rows 36 to 42 inches (91 to 107 cm) apart, seeded at rates of 1 to 2 pounds P.L.S. (Pure live seed) per acre (1.12 to 2.24 kg/ha).

A clean, firm, well prepared seedbed is necessary for obtaining good stands. Another important factor is the use of proper planting depths. Seed should be planted one-fourth (0.5 cm) to one-half inch (1.2 cm) deep and the row firmly packed with a press wheel behind the drill. Grass drills used by the Soil Conservation Service having the chaffy seed hoppers do a very good job of planting the desired rates as long as the pure seed content is below 30 percent, and high rates of bulk material are planted. The Nesbit[3] grassland drill can be used when seed quality is such that 3 to 5 pounds of bulk seed/acre (3.4 to 5.6 kg/ha) are needed to attain the desired P.L.S. planting rate.

Often, proper planting equipment is not available or timeliness in obtaining it is a problem. In these instances, growers may use alternative methods such as an Ezy-Flow[3] spreader or the fertilizer box of regular grain drills. Uniformly blending the seed in inert material, such as a coarse granulated fertilizer, or pelleting the seed in uniform size granules with either $CaCO_3$ (finely ground dolomitic limestone), Karo-syrup[3] (glucose), Methyl-cellulose, or similar pelleting adhesives may insure desired seeding rates. Broadcast seedings should be followed by cultipacking.

[3]Mention of a trade mark or proprietary product does not constitute a guarantee or warranty of the product by USDA or Oklahoma State University and does not imply approval to the exclusion of other products that may also be suitable.

SEED PRODUCTION

Seed Crop Maturity

A good-to-excellent seed crop of all three grasses can be obtained the year of establishment. Two seed crops are possible each year thereafter. The first crop matures seed in late June and the second, if managed properly, in September to early November. Potential seed growers should be forewarned that chaffy seeded grasses of this type are notoriously difficult to handle from a seed harvesting point of view, Figure 1 a, b and c. Continuous seed stalk production requires the grower to closely observe the pattern of head and field maturity and to guess the time at which to initiate seed harvesting. If good yields are attained, harvesting should be at a time when most heads are mature or near maturity, even though many are still green. Harvesting too early or too late can result in yield reduction due to immaturity or seed shattering, respectively.

Management for Maximum Yields

Various management practices for seed production under irrigation have been tried, including harvest of seed as often as a new crop is ready following heading of the first[4]. However, in these tests, higher seed yields were obtained when the species are managed for a summer and fall crop only. The recommended practice for Plains bluestem (3) is to delay the removal of the forage residue remaining after the first seed harvest, until the last week of July, then cultivate, fertilize and irrigate for a second or fall seed crop. This practice helps to avoid a seed blasting problem often associated with the fall seed crop of Plains bluestem. Seed blasting is not a problem in fall crops of either caucasian or T-strain. Therefore, the residual forage remaining after the June seed harvest of these two grasses can be mowed and baled immediately in preparing the field for a fall crop. It is essential that this operation be completed by August 1, regardless of the strain of Old World bluestem being grown for seed.

Timing Seed Harvests

Under irrigated conditions, growers can expect their best seed crop from the fall seed harvest of Caucasian bluestem, (Figures 2 and 3). Seed yields are as a rule, two to three times larger in the fall than the summer. In two out of three years at the Southwestern Livestock and Forage Research Station, El Reno, fall seed yields were six times greater than the summer yields. Occasionally, seed yields will be greater from the summer seed harvest than the fall. Seed yields of both Plains bluestem crops are considerably higher than those shown for Caucasian. Similarly, however, the fall seed harvests are usually the

[4]After heading or harvesting the summer seed crop, if the residual green vegetation is not removed in a mowing and baling operation, another crop of seed heads is produced, and can be harvested within 3 to 4 weeks of the first. Although, three to four harvests can be attained this way, seed-set is very poor and production or pure seed is much less than when managed for two crops.

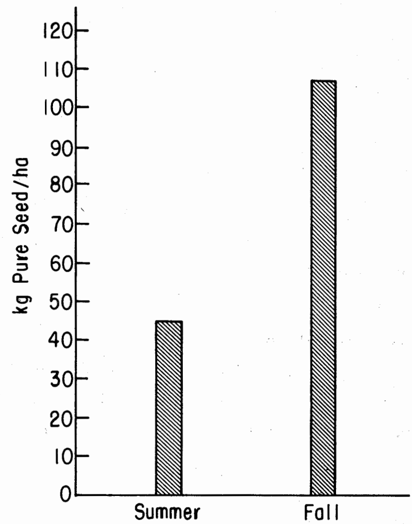

Figure 2. Mean seed yields by crop of irrigated Caucasian bluestem averaged over years and nitrogen levels. (Multiply kg/ha by 0.892 to convert to pounds/acre).

best. The reasons for this in both grasses, are the uneven pattern of maturity due to continuous seed stalk production in the summer seed crop, a heavier vegetative canopy usually associated with the summer crop interferes with the seed harvest operation, and the difficulty in timing the harvest to maximize seed yield.

The time of seed harvest has a strong influence on harvestable seed yield. When to harvest is decided by visual inspection as to stage of maturity. Inconsistence in timing the proper harvest date contributes to significant crop by years and nitrogen by years interactions. Because of this inherent problem, it is unlikely that nitrogen responses will follow the same pattern year-to-year. The summer harvest is more difficult to time properly, especially with Caucasian, than the fall. The fall crop of these two grasses generally has less vegetative cover, seed heads are more accessible, and maturity is more uniform.

Both seed crops of T-strain mature rather evenly and yields attained by crop depend on the proper timing of seed harvest, (Figure 4). Similar to production under irrigated conditions, growers of these three strains on dryland will have more difficulty in obtaining good seed yield from the summer seed harvest than the fall. Late summer and early fall moisture are conducive to rapid plant growth with a more uniform maturity pattern; thus, the seed is easier to harvest at the most optimum stage.

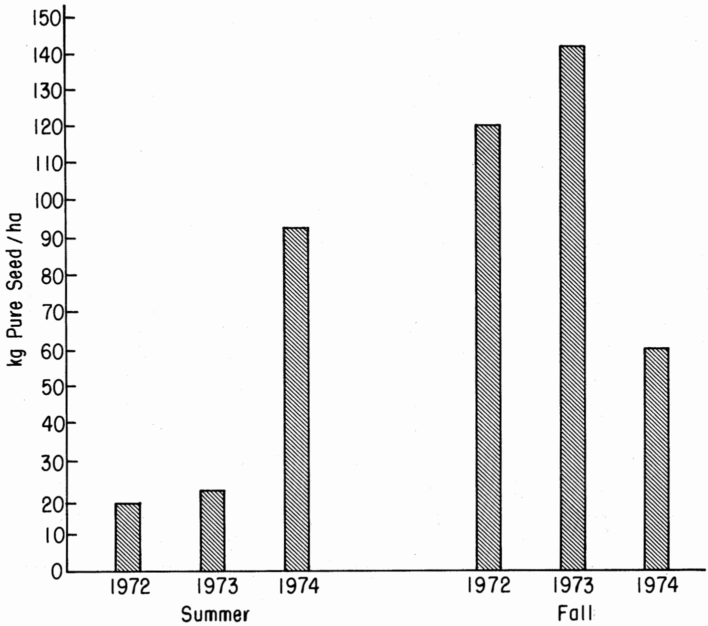

Figure 3. Mean seed yields for irrigated Caucasian bluestem for summer and fall harvests ($LSD_{0.01}$ = 35.8 kg) in 1972, 73 and 74. (Multiply kg/ha by 0.892 to convert to pounds/acre).

Fertilization

The soil fertility is important in the production of grass seed. The soil on which our studies were conducted at El Reno contained as much as 250 lb (280 kg) available phosphorus, 800 lb (897 kg) available potassium and less than 10 lb (11 kg) nitrate-nitrogen per acre. The production of both forage and seed at the station is significantly increased by nitrogen fertilization, Table 2. Where soils are less fertile, the addition of phosphate and potash fertilizer may significantly increase yields. The use of small amounts of iron, zinc and sulfur may be beneficial in some areas.

The highest seed yields are obtained when forage production is maintained at a moderate level. High forage yields, with their tall and heavy vegetative canopy, interfere with seed harvest and result in low seed yields. It is best to fertilize in early April and again in August after removal of the summer seed crops and its residue with rates of 60 to 100 lb N/acre (66 to 112 kg/ha), (Figure 5). Nitrogen rates in excess of 100 lb per acre (112 kg N/ha) under irrigated conditions will 1) increase the amount of forage produced, 2) delay maturity, 3) cause considerable lodging of plants, and 4) increase the

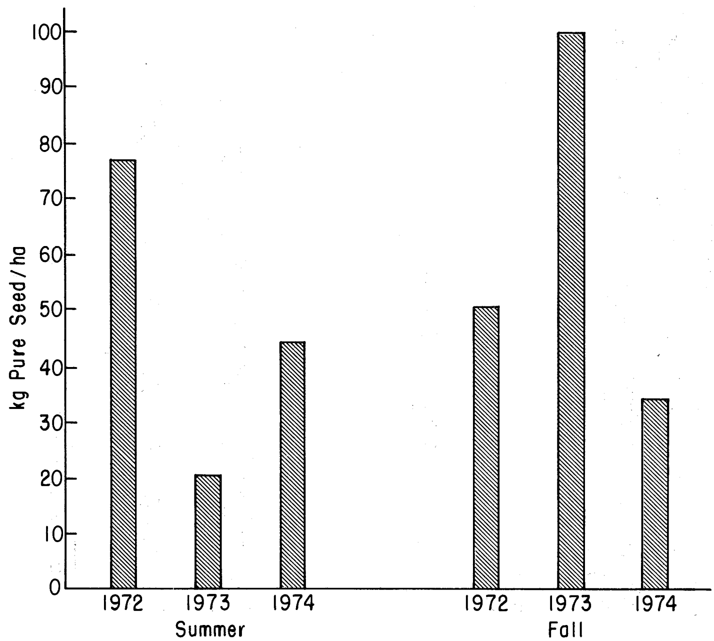

Figure 4. Mean seed yields of irrigated T-strain bluestem ($LSD_{0.01}$ = 19.9 kg) for summer and fall harvests in 1972, 73, and 74. (Multiply kg/ha by 0.892 to convert to pounds/acre).

Table 2. Average Plains bluestem yields in tons plant dry matter and pounds pure seed per acre by crop harvest as affected by nitrogen levels.

	Tons Dry Matter/Acre/Crop[1]					
	1968		1969		1970	
N-Level Kg N/ha	Summer	Fall	Summer	Fall	Summer	Fall
0	4.03	3.89	3.42	1.90	2.03	1.6
67	4.05	4.42	4.39	2.99	3.92	3.13
112	4.30	4.93*	4.61*	3.12*	4.12	3.27
Seed	Pounds Pure-Seed/Acre[2]					
0	27.4	93.5	55.4	123.0	31.2	49.1
67	47.2	97.9	111.0*	123.0	91.3*	137.0*
112	44.0	106.3	97.0	133.7	74.9	128.3*

*Significant at the .01 level of confidence.

[1]Multiply means tons (English)/acre by 2.242 to convert to metric tons/ha.

[2]Multiply pounds seed/acre by 1.121 to convert to kg seed/ha.

problems involved in harvesting seed. Supplement rainfall if needed with of 3 to 4 inches (8 to 10 cm) of water when plants are in the full leaf to boot stage of each crop. If conditions are met where a moderate vegetative cover is attained at boot, and seed stalk production is uniform and above the vegetative canopy to facilitate harvesting, irrigated yields in excess of 200 lb seed per harvest per acre (224 kg/ha) can be obtained. 1,000 lb of pure chaffy material containing 20 percent pure seed is equivalent to 200 lb pure seed.

Forage

Hay quality, especially of Plains bluestem, is good and appears to be highly acceptable to livestock. Six to nine metric tons/ha of hay under irrigated conditions can be harvested incidental to the seed production enterprise (Table 2).

Field Santitation

A haying operation may also follow the fall seed harvest, or grazing the area may be desired. However, from the standpoint of field sanitation, it may be best to leave part or all the residue lay until about March and burn. Burning in this way is an aid to weed, insect and disease control. Field burning with soil

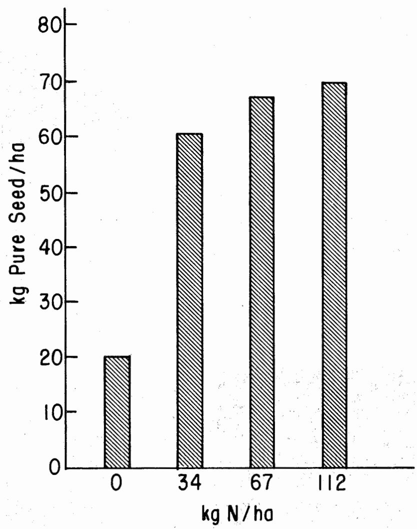

Figure 5. Mean seed yields of T-strain bluestem for nitrogen fertilization levels averaged over years ($LSD_{0.01}$ = 15.91 kg). (Multiply kg/ha by 0.892 to convert to pounds/acre).

moisture present, is not injurious to the stand; it allows complete residue or thatch removal increases the effectiveness of fertilization practices and results in more uniform spring growth.

Insects

In some years, partial to complete blasting of seed heads of Plains bluestem may occur. This is believed to be partially associated with infestation of insects during reproduction (2). Forty-nine different genera and species representing 32 families and eight orders of insects have been collected under field conditions among the inflorescences of this grass (Table 3). The effects of most of these insects on seed production are largely unknown. Blasting, however, is only an occasional problem with Plains bluestem and occurs most often in the second or fall crop. Seed blasting has not been a problem in either T-strain or Caucasian.

In Texas, the cause of seed blasting and reduced seed yields (seed-set) in the *Dichanthium annulatum* (Forsk.) Stapf. complex and in certain *Bothriochloa* species has been attributed to thrip infestations[5]. Excellent results were obtained with an early application of disulfoton, a systemic insecticide, at 6 pounds 15 percent ai granules/acre or 6.7 kg/ha. This was followed at the early boot stage with an application of diazinon at a one pint rate/acre or 1.17 l/ha. However, neither of these insecticides are presently registered for this use. The grower should be aware of insects as a potential problem and reduction in seed-set may occur in some years due to seed feeding insects, or to other causes, e.g., climatic conditions.

Diseases

No foliage diseases of T-strain, Caucasian, or Plains bluestems have been observed. Ergot and seed smut occasionally replace the caryopses, but seed diseases have not been a serious problem even in wet years. Spring burning probably aids the control of these diseases.

Nematodes

The importance of parasitic nematodes as a factor in limiting seed production of Old World bluestems has not been evaluated. Populations of four pathogenic nematode genera have been recovered from the rhizosphere of unproductive areas of several grasses in our seed production fields. These nematodes could be expected to accelerate the decline of mature stands. Nematodes such as the dagger (*Xiphinema* sp.) and root lesion (*Pratylenchus* sp.) were not recovered from the Old World bluestems discussed here although

[5]Personal communications, Dave Lorenz, SCS, PMC, Knox City.

Table 3. Insects collected among the floral parts of Plains bluestem grass grown for seed under irrigated conditions.

Order	Family	Genus and Species
Coleoptera	Elateridae	Conoderus vespertinus (F.)
		Conoderus bellus (Say)
	Phalacridae	Phalacrus sp.
Collembola	Entomobryidae	Entomobrya purpurascens (Packard)
		Entomobrya sp.
		Lepidocyrtus cyaneus Tullberg
	Sminthuridae	Deuterosminthurus spp.
Diptera	Anthomyiidae	Hylemya platura (Meigen)
	Cecidomyiidae	Anarete johnsoni (Felt)
		Cecidomyiini genus and sp. (unidentified)
	Chironomidae	Orthocladiinae genus and sp. (unidentified)
	Chloropidae	Conioscinella nuda (Adams)
	Dolichopodidae	Chrysotus sp.
	Empididae	Drapetis spp.
	Phoridae	Genus and sp. (unidentified)
	Sciaridae	Bradysia coprophila (Lintner)
		Bradysia sp.
	Sepsidae	Saltella sphondylii (Schrank)
	Sphaeroceridae	Leptocera sp.
Hemiptera	Pentatomidae	Genus and sp. (unidentified)
Homoptera[1]	Cicadellidae	Carneocephala flaviceps (Riley)
		Cicadellinae genus and sp. (unidentified)
		Deltocephalinae genus and sp. (unidentified)
		Exitianus exitiosus (Uhler)
	Delphacidae	Delphacodes sp.
Hymenoptera	Bethylidae	Perisierola cellularis (Say)
	Ceraphronidae	Ceraphron sp.
	Cynipidae	Aporeucoela sp. (near Pilinothrix sp.)
	Eulophidae	Tetrastichus sp.
	Eupelmidae	Eupelmus allynii (French)
	Formicidae	Ponera sp.
	Halictidae	Lasioglossum (Dialictus) nymphale (Smith)
	Mymaridae	Patasson sp.
	Pteromalidae	Genus and sp. (unidentified)
	Scelionidae	Telenomus spp.[2]
	Sphecidae	Cerceris finitima Cresson
	Trichogrammatidae	Abbella acuminata (Ashmead)
		Aphelinoidea plutella Girault
		Oligosita sanguinea (Girault)
Psocoptera	Lachesillidae	Lachesilla nubilis (Aaron)
Thysanoptera	Phlaeothripidae	Eurythrips sp.
		Haplothrips halophilus Hood
		Hoplandrothrips sp.
	Thripidae	Chirothrips texanus Andre
		C. spiniceps Hood
		C. texanus Andre
		Frankliniella fusca (Hinds)[1]
		F. occidentalis (Pergande)
		F. tritici (Fitch)

[1]Now considered a suborder of Hemiptera.
[2]Numerous

they were abundant in adjacent plots on other forage grass species. The Old World bluestems might be suitable for planting on land that is already infested with these nematodes. The host suitability of Old World bluestems for the more important plant-parasitic nematodes of forage grasses should be investigated.

Those nematode genera which were recovered from Plains bluestem and their maximum populations are listed in Table 4.

Weed control

Weeds and weedy grasses may be problem during establishment and can be controlled by close row cultivation. When Old World bluestem seedlings are in the 3 to 4 leaf stage, light applications of 2,4-D at the rate of ½ lb. ai/acre (0.56 kg ai/ha) can be used to control most broadleaf weeds within the row. Control measures other than cultivation are generally not needed after establishment if good uniform stands are obtained. If needed, however, an application of simazine at 1 to 3 a.i./acre pounds (1.1 to 3.4 kg/ha), applied in early April on established stands, will give effective weed control without injury to the stand. Proper rate depends on soil texture and instructions on the label should be followed.

The seed producer must be aware of the need to cultivate regardless of the weed control program he uses. Old World bluestem grasses. Plains, T-strain, Caucasian, etc., produce seed abundantly and continuously through the growing season and will volunteer readily between rows if not cultivated. Certain strains, i. e. Plains, are composite lines and it is possible that population shifts will occur in generations advanced from foundation seed. To limit possible shifts in composition the control of volunteer plants is essential in seed production stands.

Table 4. Maximum populations of plant parasitic nematodes recovered from the rhizosphere of two Old World bluestems at the El Reno research station.

	Nematodes Recovered per 100 cc of Soil	
Nematode	**Plains Bluestem**	**"S"-Strain[1]**
Spiral (*Heliocotylenchus digonicus Perry*)	28	2452
Stunt (*Tylenchorhynchus sp.*)	1408	80
Pin (*Pratylenchus sp.*)	4	224

[1]An experimental strain of *Bothriochloa ischaemum* var *ischaemum.*

SEED PRODUCTION SYSTEMS

In the production of Old World bluestem grasses, seed growers can use a single purpose or a multipurpose system of production. Each system has advantages and disadvantages.

Single Purpose Seed Production

Single purpose seed production can be practiced on both irrigated and dryland farms in areas of adequate rainfall. The growers have to be well organized and highly specialized in the production of grass seed. Seed production fields are established in rows spaced from 36 to 42 in apart (91 to 107 cm) apart, irrigated, fertilized and managed for maximum yields. One or more seed crops are produced annually. After the first seed harvest the stover is mowed and baled for hay. The hay is usually of medium quality but is considered an incidental crop. The residue remaining after a fall seed harvest is left in the field and burned in early spring for field sanitation. The advantages of this system are: 1) high seed yields, 2) excellent seed quality, and 3) high net returns. The disadvantages are high investment costs in land and specialized equipment.

Specialized Grower Information Needs

The single purpose grower selects species to produce based on the desirable qualities which have created or will create a continued interest by the consumer in the species. In selecting the kind of grass or strain of Old World bluestem to grow for seed, he is interested first in seedling vigor, ease of establishment, competitiveness with weeds, lack of disease or pest problems and response to management.

Influence of seeding rate on seed yields:

There are advantages in utilizing low seeding rates in establishing stands of some species, other than Old World bluestems, in that a large vegetative space/plant promotes the formation of tillers and thus greater yields, e.g., tall fescue. Dense stands established from high broadcast planting rates or in narrow row spacings may result in considerable decrease in seed yield with age.

Date of seeding:

Early planting, March-May, of a warm season grass must be considered if one wishes to produce a seed crop the year of establishment. Soil temperature requirement for germination, pre- and post-emergence control of weeds and weedy grasses, soil puddling and crusting following heavy spring rains, poor seedling emergence, planting depth, the fact that one must increase seeding rate in order to overcome adverse consequences of planting too late or too early, thus extra seed costs, etc., are problems growers must consider in determining when to plant. Late planting, May to mid June, has the advantage of avoiding heavy spring rains, eliminating early weed problems and allowing time in the preparation of a well-tilled firm seedbed. The seed planted in rows or broadcasted should be planted shallow, ¼ to ½ inch (0.63 to 1.2 cm). Seed zones should be packed firmly. Under excellent-to-good conditions, warm-moist soil, seedlings will emerge uniformly within 10 days of planting.

Rate of seeding:

Seeding rate is based on the row spacing of the production system. Planting in rows spaced 30-42 in apart (76 to 107 cm) requires less seed than narrower row spacings. A pound (0.45 kg) of pure-live-seed of an Old World bluestem, e.g., 'Plains' contains 478,779 rough unprocessed seed units (1,16). The appendages surrounding the caryopses of such chaffy seeded grasses often cause difficulty in planting and obtaining uniform stands. To aid in the planting and ease of handling, various degrees of processing, such as clipping or hammermilling and cleaning, increases the number of pure-seeds/pound or kg. Processing chaffy range grass seed involves the removal of some, most, or all inert attachments. Plains bluestem seed processed to the extent of removing all the surrounding chaff will contain 735,723 caryopses/lb.

Normally a 1 to 2 pound P.L.S.,/acre rate (1.12 to 2.24 kg/ha) is used to establish stands in rows 30-42 inches (76.2 to 106.7 cm) apart for seed production. Excellent stands can be obtained only when the quality of the seed is good and proper planting practices are employed.

Fertilization needs:

Grasses, like other crops, cannot attain their potential production level if the soil does not contain the fertility required. Grasses grown under the single purpose system are grown on the best soils and managed as intensively and efficiently as possible. Although adequate levels of soil K, P, Ca, etc. are essential, grass seed production is dependent on nitrogen fertilization more than any cultural practice, other than water. When nitrogen is limited, seed production is severely restricted. On the other hand, excess nitrogen produces excessive vegetative growth, induces lodging and increases harvesting losses.

The species or cultivar being grown, the age and density of stand and the climatic conditions prevailing (irrigated or dryland conditions) are factors that influence optimum nitrogen rates for seed production. Rates needed will vary from about 60 to 120 lbs. N/acre (66 to 134 kg N/ha) applied once or twice annually on dryland to 100 lb. N/acre (112 kg/ha) applied twice annually in early spring (April) and mid-late summer (Aug.) under irrigated conditions.

Water needs:

Dryland seed production of Old World bluestems in the western part of Oklahoma is unpredictable and irregular from year-to-year because of variable climatic conditions. Fifteen to 20 acre inches (51 cm) of water during the growing season for each crop by way of natural rainfall or supplemental irrigation is needed to produce maximum seed yields.

One good summer crop can be expected on dryland in areas receiving adequate rainfall during April, May and June. Where irrigation water is available to supplement rainfall or where summer and fall rainfall is sufficient, two seed crops (one in the summer and one in late fall) can be produced. When the seed crop is in boot or the early head emergence stage, irrigations should stop. The grower should let the field dry out, allow early heads to mature and shatter and then begin harvest when the later more uniformly produced heads near maturity.

Insect control:

It is apparent that considerable damage to seed-set and resultant seed yield in a number of Old World bluestem grasses is caused by insects. Many of the insects collected (Table 3) are not primarily plant feeders: *Eulophidae*, *Formicidae*, *Halictidae*, and *Sphecidae*. The habits of species of the other families listed are not well known. The size and complexity of the microfauna infesting the inflorescence throughout the reproductive phase of these grasses is scarcely appreciated and needs to be studied. However, the most prevalent insects in Old World bluestem grasses are thrips, *Chirotrips falsus* (Priesner), *Frankliniella fusca* (Hinds), *F. occidentalis* (Pergande), and *F. tritici* (Fitch).

Until the problem insects are identified and subjected to entomological study, the shotgun approach to control is the only recourse for growers. At El Reno, a foliar, full-leaf stage of growth, application of one pound ai/acre rate (1.12 kg ai/ha) of dimethoate (EC) has been used with good results. Similarly, in Texas, disulfoton 15 percent active granules applied in mid April at a rate of one pound ai/acre, followed at the boot stage with an application of one-half to one pound ai/acre of diazinon gave excellent control and increased seed yields. However, these pesticides are not registered for use on grasses and growers should check with the State Department of Agriculture for a special local needs registration.

Seed harvesting:

Seed characters such as hair, awns and other inert appendages surrounding the caryopses as well as growth habit and presence of heavy vegetative covers make the chaffy seed difficult to harvest. Thus, methods of harvesting seed vary as to kind and can determine whether good or poor yields are obtained. The indeterminate flowering habit of grasses of the Old World bluestem complex results in a prolonged period of seed stalk initiation and consequent lack of uniform seed maturity. The optimum harvest time occurs when a majority of the seed are in the medium to hard dough stage but before full maturity, at which time the seed shatter easily. After the summer grass crop is fully headed in late June and the fall crop in late September or October, maturity development should be checked frequently and closely to determine optimum harvest time.

Optimum harvest time occurs when about 20-30 percent of the seed heads in the field can be easily stripped by grasping them with the hand and gently pulling between the fingers. Seed maturity proceeds rapidly at this stage and in as few as 3-4 days much of the seed crop can be lost due to shattering. A seed crop harvested when about 20-30 percent of the heads will hand-strip easily will not result in significant loss due to previous shattering or immaturity. Seeds in the medium to firm dough stages are physiologically stable and will mature after harvest. There is never a time when all the seed is ripe.

The following harvest method is used at the Research Station, El Reno, on small acreages: seedheads are removed by "topping" the crop, using a modified grain combine. The threshing parts of the combine were removed, leaving only the sickle bar and elevator platform intact. A large collecting bin was built and hinged behind the platform in such a manner that its contents could be dumped. The seed crop is piled on the ground, or preferably on plastic sheeting, along a turn-row or other convenient place, allowed to dry, then threshed and hammermilled. After hammermilling, the material is further processed with the aid of a Clipper[3] cleaner to give the desired percentage of pure seed. Excellent results are obtained with this method, but obviously much labor is involved.

Direct combining: Direct combining can be used in harvesting seed of Old World bluestem grasses. When direct combining is used, the grower should:

1. Combine at the most mature stage, 20-30 percent seed heads can be easily hand stripped, possible without seed loss.
2. Adjust the forward speed, slow, of the combine with the width of swath so as to keep the machine evenly loaded.
3. Adjust cylinder speed to about 1300 rpm.
4. Set the cylinder-concave gap at ¼ to ⅜ in (0.65 to 0.95 cm) when moderate seed crops with seed heads above the vegetative canopy are being cut.
5. Set the cylinder-concave gap at ⅜ to ½ in (0.95 to 1.3 cm) when heavy seed crops with leaves and stems are being handled.
6. Cut off air from the cleaning fan completely by stopping the blower or

slowing to its slowest speed; cover all openings with cardboard or other suitable material and tape.

7. With the chaffy, fluffy seed unit characteristic of Plains and Caucasian bluestem and other Old World bluestems, it is impossible to separate seeds from small pieces of leaves and straw on the chaffer and shoe sieve when all air is cut off. Therefore, to prevent excessive tailing losses the shoe sieve in older combines e.g., Allis Chalmers models 60 and 66,[3] should be removed. On newer combines equipped with adjustable finger sieves on both upper and lower shoes, do not remove sieves. Open them to allow free passage of the seed to the clean grain auger below. The trashy bulk seeds are dropped to the clean grain auger and augered to the seed bin. Fluffy seeds will not auger from the bin. Therefore, it is best to sack it in large burlap bags as it reaches the combine bin. In some instances, it is necessary to occasionally brush the seed into the clean grain auger manually using a broom. This is especially true when the seed is of high moisture content.
8. Continually monitor combine tailings to detect seed losses and adjust combine or ground speed to correct these losses.
9. Synchronize reel speed so as to place the seedstalks into the cutter bar and on the platform as they are cut. Sometimes it is necessary to attach webbing or flaps to the reel slats to brush seedstalks off the cutter bar onto the platform. The reel should be set as close as possible to the cutter bar.

Swathing: Seed harvesting by direct combining is a slow process and large amounts of seed can be lost due to shattering before the operation is complete. The grower may swath his stand, allow the swath to cure, and then combine. This method, in many instances, will buy the grower time to complete harvesting without excessive seed losses providing the swath is not excessively stirred in the pickup process of combining. Swathed fields can be harvested at a later date and at a slower pace.

Stripping: Growers with large acreages will have to experiment, improvise and use experience in perfecting easier harvesting techniques, i.e. those used in pasture and rangeland areas. Harvesting seed from 'King Ranch', 'Medio', 'Gordo', and 'Angleton' bluestem varieties in central Texas is done by stripping. The method employs the principle of the old Kentucky blue grass stripper, which consists of a rotating drum with staggered rows of spikes that catch the inflorescences, strips and deposits the seed units in a hopper behind the drum. Modifications of this machine using revolving reels with wire or wooden bats and conveying threshed seed to a large trailing box have been built and used with success by seed harvesters and growers. These strippers work very well in Texas and are considered superior to direct combine harvesting. Following either method of harvesting usually scalping and/or hammermilling lightly before cleaning will prepare the seed for sale without further processing.

SEED QUALITY

A problem with these grasses is when to harvest. Judgement as to when to harvest, especially the summer seed crop, is a compromise between seed losses due to under and over-ripeness. Harvesting must start early enough to reduce seed shatter losses and late enough that harvesting does not impair seed quality. Ripe well-filled seed produce more vigorous seedlings than do poorly filled immature seeds. Seed must be properly cured before cleaning and storage.

Drying

Adequate drying facilities or space must be available. Seed piled or stored wet will heat and deteriorate rapidly. The seed harvested each day should be spread no more than 8 to 12 inches deep (20 to 30 cm) on tarps, plastic sheets, pavement or barn floors and stirred regularly until cured. During times of high humidity and cool weather it is difficult to obtain a good cure in a reasonable length of time. Artificial drying then becomes necessary. Some growers have construced metal drying barns with a false or double floor. The top floor, 12 to 18 inches (29 to 46 cm) above the bottom, is covered with fine mesh perforated sheet metal. The space between floors allows for the passage of a heated forced air flow. The forced air flow is supplied by large air blowers or commercial drying units that heat the air. These units are vented from outside into the space under the false floor. The sides of the barn are vented to allow the removal and flow of the moist air coming off the seed to the outside. Depending on the depth of seed, the uniformity of air flow, etc., chaffy seeds such as the Old World bluestems can be cured in a reasonably short time, 8 to 36 hours.

Seed Quality and Purity Analysis

Grass seed is marketed and planted on the basis of percent pure-live-seed (percent pure seed content × percent germination). The grower can obtain an estimate (16) of the percent pure-seed content of Old World bluestems by drawing three to four random samples from his seed lot, thoroughly mixing these together and then drawing a subsample of known weight, usually five to 10 grams. Extract the caryopses or naked grain from the subsample using a grooved rubber mat glued on the bottom surface to a small thrashing box. A small piece of the rubber mat should also be glued to a 4 to 5 inch (10 to 13 cm) length of 1 × 4 (2.5 × 10 cm) lumber to be used to create an abrasive action for thrashing. The thrashed material is passed at intervals through a screen and is then blown lightly to separate chaff and pulverized inert material from the caryopses.

Weight of extracted caryopses divided by the original subsample weight × 100 = percent caryopses by weight. Multiply the percent caryopses by 1.8, the conversion factor correcting for floral parts normally around the seed, to give the percent chaffy pure-seed content. The entire procedure is an objective test requiring only 10-15 minutes and estimates the pure-seed content with more reliability on random bulk samples than the official AOSA tests (23).

MULTIPURPOSE SYSTEM OF SEED PRODUCTION

A multi or dual purpose system of seed production exists where stands of improved grasses are planted primarily for grazing and haying purposes, but are managed for seed when prices are favorable. The majority of such production is produced under dryland conditions so that yields are unpredictable and irregular from year to year. Consequently, seed supplies are unreliable and usually low quality.

The advantages of such a system: 1) allows light grazing of livestock to within a week or two of harvest or heavier grazing during certain periods of time, 2) after a seed crop is harvested livestock are returned at a heavier stocking rate or fields are mowed for hay, and 3) low cost of production. Disadvantages are: 1) stands established on land that often has no alternative use, low nutrient level, etc., 2) poor seeds yields-often less than 30 bulk pounds per acre (34 kg/ha), 3) seed produced is usually low quality because of low pure-seed content and poor germination, 4) yields are unpredictable and irregular from year to year, 5) contamination of the intended species with other Old World bluestem strains is of no concern to harvester, and 6) weed seed content may be excessive.

Multipurpose management schemes for seed production can be easily worked-out for a large number of grasses. However, grass seed production must be improved by increasing and stabilizing not only yield but the areas from which seed is or will be produced. Unfortunately, the stability and growth of a grass seed production industry in the state and the southern Great Plains area as a whole will never be feasible until *consumers demand certified seed of improved strains*.

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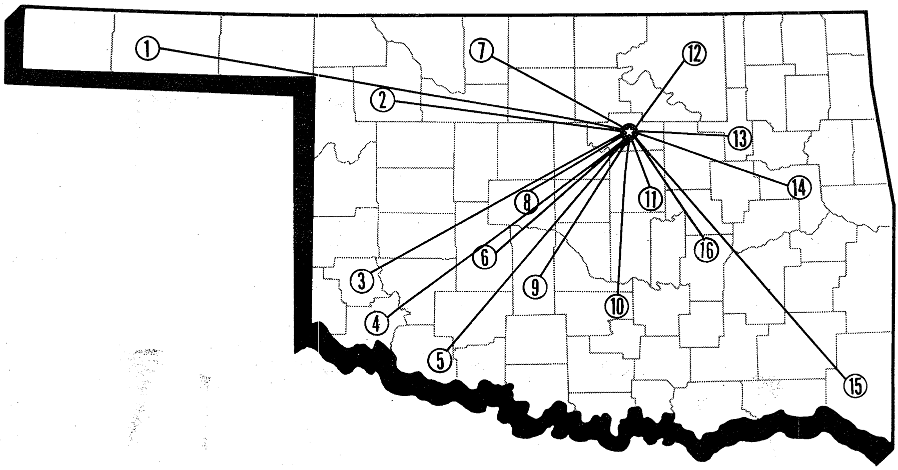

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