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Producing certified seed of Bromegrass

in Western Canada

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Producing certified seed of Bromegrass in Western Canada

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Bromegrass seed has been produced in Western Canada for more than 30 years. From 1934 to 1940, production averaged 2,400,000 pounds of seed annually. Production expanded to 8,800,000 pounds from 1941 to 1960 and decreased to an average of about 6,000,000 pounds from 1961 to 1967. Lower production in recent years has been partly the result of reduced use of Canadian bromegrass in the United States. Southern varieties, rather than northern varieties, are now recommended in many parts of the United States, and there has been some replacement of bromegrass by other grasses and by corn, sorghum, and Sudangrass.

Bromegrass seed will continue to be in demand because of its wide use for forage in Western Canada and Ontario. Southern varieties from the United States are hardy in Western Canada, and seed of these varieties will likely have an export market. Since 1961 approximately 40 percent of Canadian bromegrass seed has been exported, mostly to the United States. The climate of Western Canada is favorable for the production of heavy, well-filled seed. Fortunately, annual weedy bromegrasses are not a problem in Western Canadian seed districts. Market opportunities are best for the named varieties.

Producing seed of bromegrass and most other forage seeds is becoming specialized. Growers should keep informed on the changing demands for varieties. The Certified label can be used only for named varieties, and fields have to be inspected. To produce pedigreed seed, it is necessary to establish fields with Foundation seed. Isolation strips must be maintained to prevent interpollination of strains. Field and seed inspection must be arranged for as required by the Canadian Seed Growers' Association. Production will be profitable only if growers use good management of fields, including the use of nitrogen fertilizers. Though the average seed yield of bromegrass is slightly over 100 pounds per acre, this amount can be doubled or tripled with good management. For example, under favorable conditions yields of 1000 pounds per acre have been recorded in Western Canada.

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AREAS AND SOILS SUITABLE FOR BROMEGRASS SEED PRODUCTION

Bromegrass seed production is most successful on loam and sandy loam soils of the Dark Brown and Black soil zones. On heavy soils, stands become sod-bound and unproductive of seed after a few seed crops. Grain production is usually more profitable than bromegrass seed production on heavy soils. Production in the Brown soil zone runs the hazard of drought, which can reduce heading and seed setting; in fact, outright killing may follow a severe drought. Though seed production for many years was confined to specific districts, in recent years production has been successful in many areas.

Freedom from quack grass, or couch grass, is of the utmost importance. Certified seed has zero tolerance for this weed. Seeds of quack grass are similar in size to those of bromegrass and cannot be removed with cleaning machinery. Unless fields intended for seed production are absolutely free of this weed do not undertake seed production.

VARIETIES TO GROW

Many tests have been made of bromegrass varieties in Canada in recent years. Table 1 presents a list of varieties licensed for sale in Canada and the relative yields of these varieties in Western Canada. Additional varieties not licensed in Canada are being grown under contract arrangements with seed firms.

TABLE 1 COMPARISON OF HAY AND SEED YIELDS OF BROMEGRASS VARIETIES IN COOPERATIVE TESTS AT EXPERIMENTAL STATIONS AND UNIVERSITIES IN WESTERN CANADA, 1953-1967

Variety	Type	Where developed	Yield* (%)	
			Hay	Seed
Carlton	Northern	Saskatchewan	105	126
Manchar	Northern	Washington State	104	100
Lincoln	Southern	Nebraska	106	75
Fischer	Southern	Iowa	104	77
Saratoga	Southern	New York	107	56
Redpatch	Southern	Ontario	102	59
Magna	Southern	Saskatchewan	115	130

*Yields are given as percentages of northern common.

Some southern varieties have good hay yields in both Eastern and Western Canada. The southern type of bromegrass was discovered in old established fields in Nebraska and Kansas about 1940. Varieties were developed that were much superior to northern bromegrass in these and adjoining states. In these areas southern

varieties show better establishment and higher forage yields than northern bromegrass. Southern varieties are reasonably hardy in Western Canada. They have good forage yields but lower seed yields than northern bromegrass. Southern varieties are taller, more strongly creeping, and less leafy than northern varieties. They are coarse-stemmed and resistant to lodging. Their seeds look larger than those of northern bromegrass because of wide papery margins. Southern varieties generally are more resistant than northern bromegrass to leaf-spot diseases. Southern varieties turn green earlier in the spring than northern bromegrass, and often remain greener in the fall.

A short description of the varieties of most interest for seed production follows.

Carlton—Carlton, a variety of the northern type, is particularly adapted to Saskatchewan and Alberta. In Manitoba, it is usually outyielded by varieties of the southern type, at least in southern districts. This variety has high seed yields, giving 20 to 30 percent more seed than northern common. Carlton, similar to northern common, has low resistance to leaf-spot diseases. The Certified seed production of this variety is extensive in Saskatchewan and Alberta.

Manchar—Manchar resembles northern common in yields of hay and seed and in appearance. However, it makes rapid spring growth and has good aftermath. Manchar is a favored strain under irrigation. The variety is grown, on a limited scale, for seed production in Alberta and is widely recommended in the Northwestern States.

Lincoln—Lincoln was one of the first varieties of the southern type to be recognized. It is widely recommended in the United States. Lincoln has shown good forage production and reasonably good seed production in Western Canada. The variety is recommended in Ontario and Manitoba. Some seed is being produced in Western Canada.

Fischer—Fischer, a southern variety, is slightly inferior to Lincoln in hay yields in Western Canada. It has shown good production in some areas of Quebec, and has been recommended in that province.

Saratoga—Saratoga has excellent forage yields and good aftermath. It is widely recommended in the United States, Ontario, and Quebec. A large amount of this seed is grown in Western Canada. Seed yields are inferior to those of northern common or Carlton. However, with good management practices growers have obtained quite profitable yields.

Redpatch—Redpatch is the first variety of a southern type developed in Canada. It is a high-yielding variety in Ontario and Quebec. Seed yields of Redpatch are low in comparison with northern common or Carlton in Western Canada. Because it is widely recommended in Ontario, a seed market appears assured.

Magna—Magna is largely of southern Fischer parentage, and combines the good forage yield of the southern type with high seed yields. It was released in 1968 and a fairly wide use is expected. Tests in Ontario, Quebec, Wisconsin, and Minnesota show moderately good production in comparison with other varieties. In Manitoba, Magna has a considerable yield advantage over northern common and

Carlton. It shows some advantages over Carlton in Saskatchewan but not so many in Alberta.

Blair, Baylor, Sac, and *Polar*—The varieties Blair, Baylor, Sac, and Polar from the United States are being grown for seed under contract arrangements. Blair and Baylor, in limited testing, have shown excellent forage yields and fairly good seed yields. In Western Canada, seed yields of Sac are approximately 60 percent of those of common. Polar, a variety from Alaska, has shown yields similar to common in very limited testing in Western Canada.

BECOMING A CERTIFIED SEED GROWER

The pedigreed seed classes apply only to named varieties. Common bromegrass, which is grown from old established fields, can no longer be certified as "quack-free," and will not be field inspected. Varieties of bromegrass developed in Canada have three classes of seed: Breeder, Foundation, and Certified. Breeder seed is produced in small quantities by plant breeders, experimental stations, or institutions. Foundation is the next generation of seed and is obtained from fields planted with Breeder seed. Similarly, Certified seed is grown from fields established with Foundation seed. Only one generation of each class is allowed, but seed crops can be harvested from an established stand for 6 years.

Foundation seed generally is grown under contract arrangements with the Canadian Forage Seed Project. Foundation seed is then distributed by provincial departments of agriculture and by members of the Seed Multiplication Division of the Canadian Seed Trade Association to growers on request. The Canadian Seed Growers' Association (C.S.G.A.) establishes the crop standards used by member growers, and issues seed certificates for those crops meeting the standards. The Plant Products Division, Production and Marketing Branch, Canada Department of Agriculture, makes inspections of Certified and Foundation seed fields, checks representative seed samples of the crop for quality and grades, seals seed, and cooperates closely with the Canadian Seed Growers' Association.

To obtain information on growing Certified seed, write to the central office of the C.S.G.A., G.P.O. Box 455, Ottawa 2, Ontario. Secretaries of provincial branches of the C.S.G.A., associated with provincial departments of agriculture, also may be contacted. Seed firms will supply information on producing pedigreed seed and often will supply the necessary Foundation seed for the establishment of Certified seed fields.

If you want to grow pedigreed seed, you should read the C.S.G.A. regulations before seeding your fields. These regulations specify the type of land preparation needed and the isolation distances necessary to prevent outcrossing with other varieties. Bromegrass is a cross-pollinated grass, and therefore an isolation distance of 50 yards is needed to prevent contamination from roadside bromegrass or fields of other varieties. This distance can be reduced under certain conditions by removing borders. Isolation serves a double purpose by isolating fields from quack grass that may be present on fence lines and roadsides.

Row Spacing

Most seed fields of bromegrass are solid-seeded because they are easier to manage. However, tests show higher seed yields from 2-foot and 3-foot row spacings than from 6-inch and 12-inch row spacings (Figures 1 to 4). At Saskatoon, 3-foot spacing and establishment without a companion crop gave an average seed yield of 180 pounds per acre over four harvests, whereas 6-inch spacing gave 89 pounds per acre. In 6- and 12-inch spacings, yields dropped off after the first two harvests because the stands became sod-bound. The wide-spaced rows maintained higher yields for a longer period. Spaced rows allow stands to escape drought and its harmful effects on seed yields. Southern varieties, in particular, benefit from wide row spacings (Figure 4).

Wide rows are hard to harvest if the swath falls between the rows. In some seed crops, groups of three rows spaced 1 foot apart are seeded at intervals among wide rows so that the swath can be placed on these groups and more easily picked up.

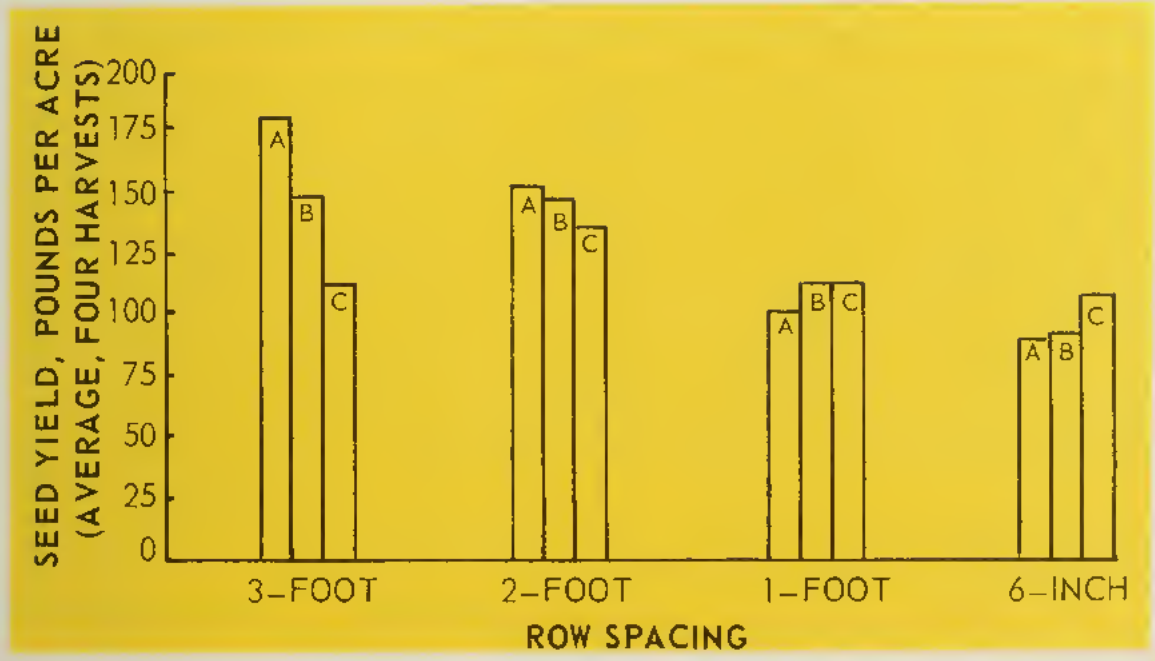

Figure 1. Seed yields of common bromegrass at Saskatoon using 4-row spacings and three methods of establishment. The results are based on three tests, 1952 - 1961. No fertilizer was applied and inter-row cultivation was 3-foot spacings only. *A*, no companion crop, 2,4-D applied; *B*, no companion crop, weeds mowed; *C*, wheat companion crop, 2,4-D applied.

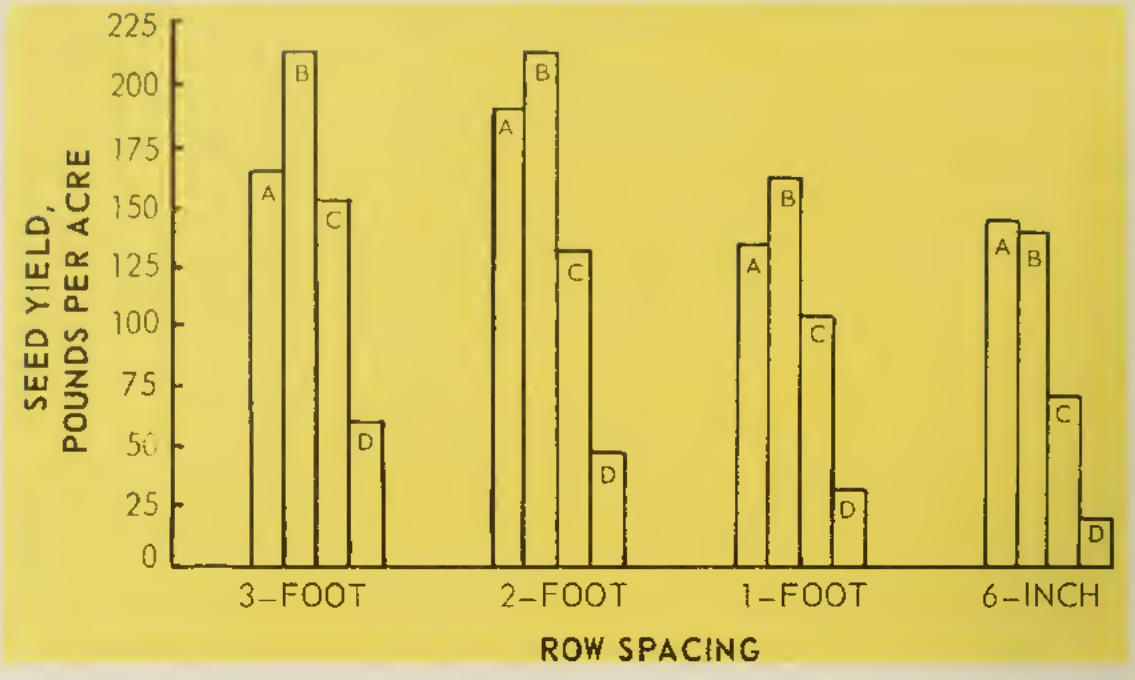

Figure 2. Seed yields of common bromegrass at Saskatoon using 4-row spacings according to harvest year. The results are based on three tests, 1952 - 1961. No fertilizer was applied and inter-row cultivation was for 3-foot rows only. Average of three methods of establishment. *A*, first crop after seeding; *B*, second crop after seeding; *C*, third crop after seeding; *D*, fourth crop after seeding.

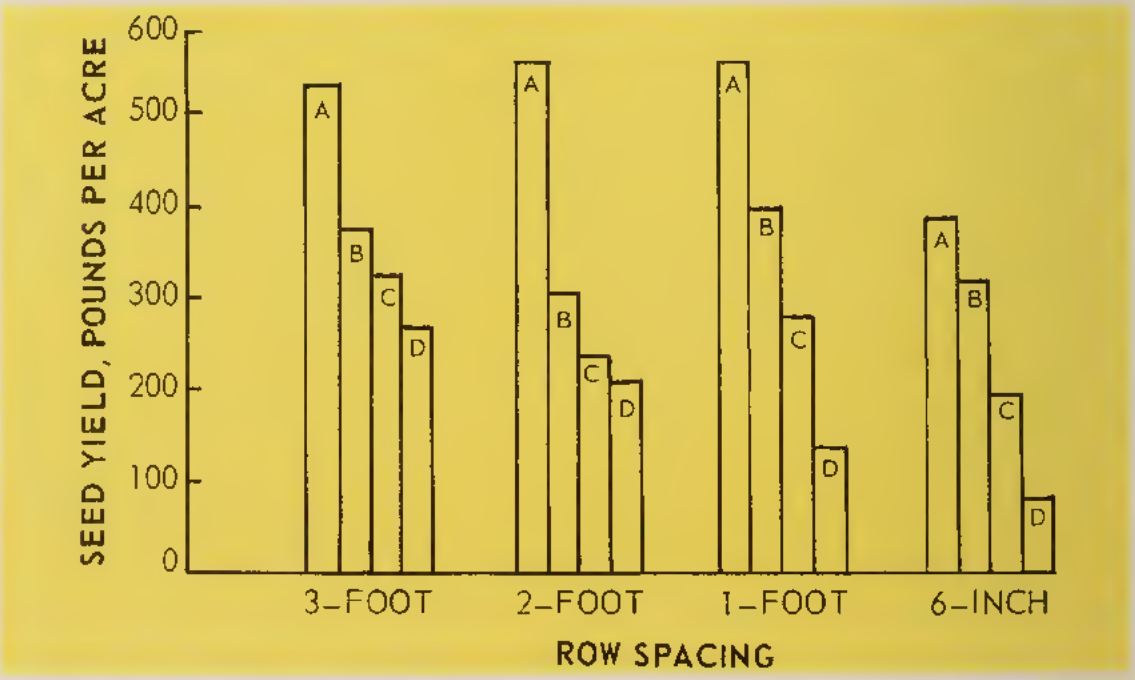

Figure 3. Seed yields of common bromegrass at Melfort using 4-row spacings according to harvest year. The results are based on a single test, 1949 - 1952. No fertilizer was applied. *A*, first crop after seeding; *B*, second crop after seeding; *C*, third crop after seeding; *D*, fourth crop after seeding.

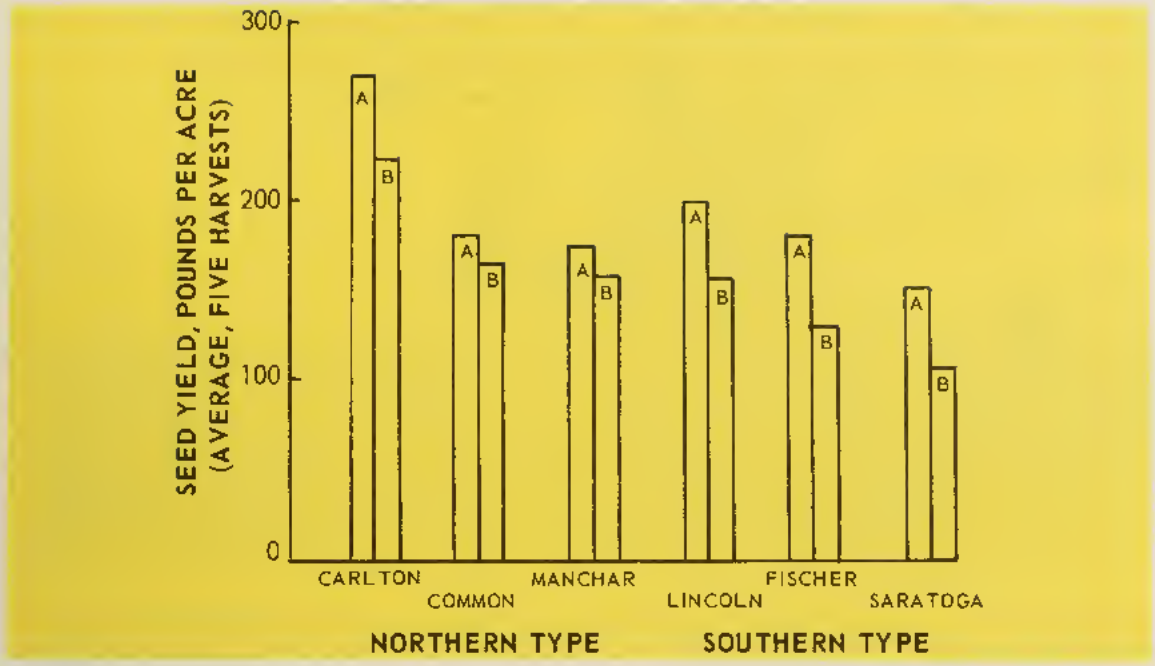

Figure 4. Seed yield of bromegrass varieties at Scott, Saskatchewan, 1958 - 1962. *A*, rows 3 feet apart; *B*, rows 1 foot apart.

Companion Crops and Herbicides for Weed Control

Seeding a cereal companion crop along with bromegrass usually results in lower seed yields in following years. It is preferable to control weeds by mowing or with herbicides (Figure 1). However, companion crops help in the prevention of soil drifting, which may occur on fallow land. If a companion crop is used, cut its seeding rate in half to reduce competition for the grass. Seeding wheat at very light rates of 1 or 2 pecks per acre will help prevent soil drifting, and if mown off in July will cause little competition. If sown in rows with the grass, the grain crop serves to mark the rows for inter-row cultivation. Do not use oats for this purpose, because volunteer oats (and wild oats) are hard to separate from bromegrass seed.

Herbicides give excellent control of weeds in new plantings of bromegrass. Use 4 to 8 ounces active ingredients of 2,4-D after the grass seedlings have reached the three-leaf stage.

Bromegrass is very susceptible to Avadex (diallate) and Avadex BW (triallate). Fields that have been treated with these chemicals should not be seeded to bromegrass for at least 1 year after the treatment.

When to Seed

In the Prairie Provinces seed in early spring. Seeding around September 1 or in late October also may give satisfactory stands. Early September seedings are recommended only when moisture conditions are favorable. In parkland areas, seed before July, otherwise plants do not have time to establish themselves before the

onset of winter. Fall seedings should be on clean stubble, whereas spring seeding should be on fallow or well-prepared stubble land. Fall seedings do not result in seed crops the next year, as plants are not fully established.

Method of Seeding

Whether sown alone or with a companion crop, do not seed bromegrass deeper than 1 inch. Seeding into a firm seedbed, such as unworked stubble, helps ensure shallow seeding. To keep bromegrass seed flowing freely through the drill, do not fill the drill box more than half full. If the drill does not have a seed agitator, watch for stopped drill runs.

Rate of Seeding

Use lower rates of seeding when growing bromegrass for seed than when growing it for hay or pasture. Light rates of seeding keep the crop from becoming sod-bound for a longer period. Use 4 to 5 pounds of seed per acre for drills 12 inches apart, and 2 to 3 pounds per acre for seeding in rows 2 to 3 feet apart. Some Foundation growers have obtained excellent stands from seeding at 1 pound per acre in rows 3 feet apart. A good rule to follow is to set the drill to seed 12 to 20 seeds per foot of drill run. This can be checked by driving the drill over a hard surface, such as a road, and counting the number of seeds that fall per foot. Another guide is to set the drill to seed 8 pecks on the wheat scale and to adjust the rate from this according to the amount of seed used to seed the first acre.

HARVESTING AND HANDLING SEED

Methods of Harvesting

The safest method of harvesting bromegrass seed is to swath the crop and then pick it up when the swath is dry. Straight combining when the seed heads are fully ripened is a simpler method of harvesting, but the risk of shattering is high. When the crop is ready for straight combining, a strong wind can mean a lost crop. However, straight combining is recommended when crops are light. Curing in the swath reduces the danger of seed heating.

Experiments show that germination of the seed is not impaired if there is as much as 45 percent moisture in the seed at the time of swathing. However, if the crop is straight combined, the seed should not contain over 25 percent moisture, otherwise germination of the seed is reduced. Apparently the seed continues to mature if it remains attached to the stem in the swath. Because seed will shatter when the moisture content is around 25 percent, there is danger of seed loss while waiting for straight combining.

Bromegrass herbage has fair feed value at the time the seeds are harvested. Feeding trials show that the nutritive value is approximately two-thirds that of bromegrass hay cut at the flowering stage. As swathing can be done earlier than

Figure 5. Harvesting bromegrass seed: *A*, combine with bagging platform; *B*, swathing bromegrass; *C*, picking up; *D*, handling seed in bulk.

straight combining, a better grade of forage is obtained with swathing. If the seed crop is straight combined, cut the stubble for hay as soon as possible, because leaves deteriorate rapidly once the seed heads have been removed.

When to Harvest

Fields usually are ready to swath in late July or early August and ready for straight combining about 10 days later. Seed heads take on a brownish color as they ripen, and the upper parts of the stem turn from green to brown. Southern varieties are lighter brown than northern varieties. Swathing should be done when heads are brown and the upper parts of stems are turning brown. The crop is ready for straight combining when the seeds are easily stripped from the stems by hand. At this time, if seed heads are struck sharply across the palm of the hand, the seed will shatter out.

Combine Settings

Bromegrass is more easily threshed than grain crops, but separation of seed and straw is more difficult. Do not feed the combine as heavily as when threshing grain. Check the quality of the seed, tailings, and straw regularly, as they are guides to the proper setting of the combine. Inspect the combine regularly for stoppages or clogging of the return, sieves, and straw decks.

Reduce the cylinder speed by 100 to 200 rpm from that used for wheat. Too great a reduction in cylinder speed is likely to result in clogging of the straw decks. Adjust concaves to remove all seed from heads and yet not to cause shelling or peeling of seeds or excessive breakage of the straw. Short pieces of straw are hard to remove from bromegrass seed. In spike-tooth cylinders all concave teeth may be removed and replaced with blanks. For rub-bar cylinders, close concaves slightly from the settings used in threshing wheat. Examine the threshed seed to see that spikelets are threshed out as single seeds. Seed-cleaning plants generally do not rethresh seed, and seeds attached to one another will be taken out as dockage.

Wind setting is very important, so reduce the air blast or cut it off entirely. Inspect the tailings to see that no filled seeds are blown over. Seed-cleaning plants expect from 10 to 20 percent inert matter in the seed as it comes from the grower. Delivery of overly clean seed is an indication that some of the lighter seeds were lost. Open adjustable sieves wider than the settings used for wheat. Some straw may clog the round-hole sieves at the rear of the adjustable sieve. This can be overcome by substituting short-extension adjustable sieves or blank pieces of tin or galvanized iron in place of the round-hole sieve.

Cleaning and Handling Seed

Bromegrass seed usually is bagged loosely in 100-pound sacks on the combine. In some districts, bulk seed is delivered directly to the seed plant. Bagging seed on the combine reduces the danger of heating and allows delivery to the seed plant, where cleaning can be delayed until it is convenient. When left upright in

groups in the field, bags of seed will dry and shed considerable rain. Seed plants that want the seed delivered in bags will supply sacks to the grower. Combines can be modified with a platform for sacking the seed while the machine is operating. Seed, whether sacked or in bulk, should be watched for heating, especially for the first 24 hours. If seed has a musty smell, it is likely to have low germination as a result of heating.

Seed is usually cleaned by seed plants rather than by growers. However, good cleaning can be done on the farm with a fanning mill, especially when followed with an indent disc cleaner. Sieves suggested for scalping are oblong sieves 1/12 X 1/2 or 1/13 X 1/2. Broken straws are most easily removed with fairly large round-hole sieves such as a 14/64. Indent machines can be used in two ways: in the usual manner to pick out good seeds, with straw and sterile florets going out the far end of the machine; or with small indent discs to remove small weeds, with the bromegrass going out the far end of the machine. In the first arrangement discs used for barley are satisfactory, whereas in the second arrangement discs used for flax can be used. Indent machines buff seeds by removing the papery edges. When this has been done the seeds flow more readily through seed drills. Tests show that the weight of seed is increased 1 to 2 pounds per bushel by a single passage through an indent disc cleaner. Do not remove the hulls from the seeds in threshing or cleaning because this lowers germination.

MANAGEMENT OF SEED FIELDS

Using Fertilizer

Nitrogen fertilizers usually are profitable in the seed production of bromegrass. They help prevent declining yields of old stands, as shown in Figures 2 and 3. Southern bromegrass varieties, in particular, respond to nitrogen applications. Phosphorus fertilizers generally are not beneficial. However, if soil tests show deficiencies of phosphorus, then phosphorus should be applied for the life of the stand at time of establishment.

Nitrogen applied in September gives better seed returns than when it is applied in October and much better results than when applied in the spring. Applications of 40 to 80 pounds of nitrogen per acre (120 to 240 pounds of ammonium nitrate 33.5-0-0) may result in some carryover effects on two following seed crops. Table 2 shows results from the Experimental Farm at Scott for extensive tests in the Dark Brown soils of the Unity - Scott - Wilkie area. Table 3 gives results also obtained by the Experimental Farm at Scott for degraded Black soils of northwestern Saskatchewan.

Seed yields of bromegrass (*see* Tables 2 and 3) are increased two or three times by using high rates of nitrogen fertilizers. The greatest increase in yield of seed per pound of fertilizer applied is obtained from low rates of fertilizer application. Approximately 1 pound of additional seed is produced for each pound

TABLE 2. EFFECT OF NITROGEN FERTILIZERS ON SEED YIELD OF BROMEGRASS ON DARK BROWN SOILS AT SCOTT, SASKATCHEWAN, AFTER FERTILIZER WAS BROADCAST IN SEPTEMBER

Treatment	Seed yields (pounds per acre)		Increase per pound of fertilizer	
	1951 - 1957	1959 - 1965	1951 - 1957	1959 - 1965
Check – no fertilizer	107	162	–	–
Ammonium nitrate* at 60 pounds per acre	176	249	1.15	1.45
Ammonium nitrate at 120 pounds per acre	208	298	0.84	1.13
Ammonium nitrate at 240 pounds per acre	263	366	0.65	0.85
Ammonium nitrate at 480 pounds per acre	–	360	–	0.41

*33.5-0-0.

TABLE 3. EFFECT OF NITROGEN FERTILIZERS ON SEED YIELD OF BROMEGRASS IN NORTHERN FORESTED AREAS OF SASKATCHEWAN

Treatment	Seed yields (pounds per acre)		Increase per pound of fertilizer	
	Loon Lake 1962 - 1965	Turtleford 1959 - 1965	Loon Lake 1962 - 1965	Turtleford 1959 - 1965
Check – no fertilizer	75	154	–	–
Ammonium nitrate* at 60 pounds per acre	137	226	1.03	1.20
Ammonium nitrate at 120 pounds per acre	202	294	1.06	1.17
Ammonium nitrate at 240 pounds per acre	308	359	0.97	0.85
Ammonium nitrate at 480 pounds per acre	–	422	–	0.56

*33.5-0-0.

of ammonium nitrate fertilizer (1/3 pound of nitrogen) applied. You can make a quick assessment of the value of applying fertilizers when you know the price of bromegrass seed.

The response to fertilizer depends very much on moisture conditions. In dry years no benefit may be noted. At Scott fertilizers were more beneficial during the wet period 1963 - 1965 than during the drier period 1951 - 1957. The higher yields for the heavy rates of fertilizer shown for northern Saskatchewan resulted from better moisture conditions.

Fertilizers increase hay yields as well as seed yields. In the trials at Scott, from 1951 to 1957, hay yields increased from 0.66 ton per acre with no fertilizer to 1.25 tons at the 240-pound rate of application of ammonium nitrate. In northern Saskatchewan this same fertilizer application increased hay yields from 0.46 ton per acre to 1.38 tons per acre.

Nitrogen fertilizers should be broadcast on the surface of the soil. Drilling fertilizer into the ground has shown no benefit over surface applications.

Removing Stubble

In several countries, when the extra leaves and stems were removed from seed fields by mowing, burning, or grazing, the seed yields of various grasses increased. In experiments with bromegrass in Saskatchewan, seed yields increased 20 to 30 percent after burning or mowing and discarding old growth. A response was shown to both late fall and very early spring burning. Under dry conditions, benefit was slight. Where heavy stubble has accumulated, it is best to remove it by burning or mowing for hay.

Rejuvenating by Tillage

Rejuvenation of old stands of bromegrass by shallow plowing results in markedly increased seed yields. At Saskatoon, old stands plowed every 4 years gave seed yields of 161 pounds per acre from 1952 to 1960 (including the years of rejuvenation when no seed was obtained), whereas unplowed bromegrass gave an average yield of only 76 pounds per acre. Plowing should be done in early spring or fall. Plowing in midsummer may kill the stand, especially if moisture is lacking. Discing and narrow-tooth cultivators do not give as good results as shallow plowing.

Spraying for Weed Control

The best way to control broad-leaved weeds is by using herbicides in the establishment year. In subsequent years, 2,4-D at 8 ounces active ingredients per acre may be used without damage to seed crops until the late boot stage. Fall applications after the seed crop has been taken off are best for hard-to-kill perennial weeds.

Eradicating Bromegrass

Eradicate bromegrass by plowing during July, after the hay crop has been removed. Plow deeply and work the sods down thoroughly with heavy discing or packing. Under favorable moisture conditions, regrowth will occur, which will need continued cultivation for the rest of the season.

HAZARDS OF SEED PRODUCTION

Do not undertake the production of seed before you have considered the problems it entails. As a prospective grower you must be prepared for occasional seeding failures. Forage crops are more sensitive than cereal crops to damage from too deep seeding, drought, soil drifting, and insect pests. If you use a companion crop at the full seeding rate, the grass may be greatly weakened in the first crop year, and full production will be obtained only in the third or fourth year.

Leaf-spot diseases may cause damage to seed yields in wet years, particularly in parkland areas. Burning old growth reduces this danger. Occasionally in wet years, such as 1966, seed may fail from unknown reasons. Late spring frosts may damage head formation. "White-heads" noted in certain years appear to result from insect damage.

Returns to growers have fluctuated widely as a result of the extreme variability in yields and prices of seed. Bromegrass fields usually have low moisture reserves, unless seeded in wide-spaced rows, and are very dependent on rains in May and June, when active growth is taking place. Over the past 25 years the price of bromegrass seed to growers has varied from 5 to 40 cents per pound in Western Canada. Since one-third of the Canadian seed produced is marketed in the United States, prices in Canada are dependent on production and prices in the United States.

For the grower who is willing to stay in seed production for a number of years and to manage fields for maximum yields, there are opportunities for profitable production of bromegrass seed. Production is most successful when other benefits, such as soil improvement or the provision of hay and pasture, are derived from growing the crop.

OTHER HELPFUL INFORMATION

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METRIC EQUIVALENTS

LENGTH

inch	= 2.54 cm	millimetre	= 0.039 in.
foot	= 0.3048 m	centimetre	= 0.394 in.
yard	= 0.914 m	decimetre	= 3.937 in.
mile	= 1.609 km	metre	= 3.28 ft
		kilometre	= 0.621 mile

AREA

square inch	= 6.452 cm^2	cm^2	= 0.155 sq in.
square foot	= 0.093 m^2	m^2	= 1.196 sq yd
square yard	= 0.836 m^2	km^2	= 0.386 sq mile
square mile	= 2.59 km^2	ha	= 2.471 acres
acre	= 0.405 ha		

VOLUME (dry)

cubic inch	= 16.387 cm^3	cm^3	= 0.061 cu in.
cubic foot	= 0.028 m^3	m^3	= 31.338 cu ft
cubic yard	= 0.765 m^3	hectolitre	= 2.8 bu
bushel	= 36.368 litres	m^3	= 1.308 cu yd
board foot	= 0.0024 m^3		

VOLUME (liquid)

fluid ounce (Imp)	= 28.412 ml	litre	= 35.2 fluid oz
pint	= 0.568 litre	hectolitre	= 26.418 gal
gallon	= 4.546 litres		

WEIGHT

ounce	= 28.349 g	gram	= 0.035 oz avdp
pound	= 453.592 g	kilogram	= 2.205 lb avdp
hundredweight (Imp)	= 45.359 kg	tonne	= 1.102 short ton
ton	= 0.907 tonne		

PROPORTION

1 gal/acre	= 11.232 litres/ha	1 litre/ha	= 14.24 fluid oz/acre
1 lb/acre	= 1.120 kg/ha	1 kg/ha	= 14.5 oz avdp/acre
1 lb/sq in.	= 0.0702 kg/cm^2	1 kg/cm^2	= 14.227 lb/sq in.
1 bu/acre	= 0.898 hl/ha	1 hl/ha	= 1.112 bu/acre

INFORMATION
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