Poa pratensis L.

KENTUCKY BLUEGRASS

Seed Production of Kentucky Bluegrass

Canada

Canada's Green Plan / Le plan vert du Canada

CSAGPA

Sask Forage Council

Saskatchewan

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I. Introduction

Seed production of Kentucky bluegrass in Saskatchewan has been sporadic prior to the 1990's, but it has been common in the wetter areas of southeastern Manitoba for decades. Interest in seed production of Certified and Elite varieties of Kentucky bluegrass in irrigated areas is a recent development on the prairies. Western Canadian acreage has risen sharply in the past few years to several thousand acres during times of relatively low grain prices as farmers search for rotation alternatives for vegetable and specialty crops and as contracting companies look for additional production areas. Production has varied between 50 - 250 tonnes for several decades.

Kentucky bluegrass (*Poa pratensis* L.) was introduced from Europe by colonists in the early 1600's. The grass is called "smooth meadow grass" in Europe, but became known as bluegrass in North America by 1750. The grass followed the movement of settlement westward and became known as the "white man's foot grass" to the natives.

The grass is traditionally included as a component in lawn mixtures, but a significant amount of Kentucky bluegrass is also sown in pastures throughout the prairies in the transition zone between the prairie and the forest. As a pasture grass, Kentucky bluegrass is highly palatable and nutritious during spring, but must be grazed frequently to maintain its succulence and palatability.

Approximately 70 varieties of Kentucky bluegrass are licensed in Canada, but only a handful of these are grown for seed within the country. The marketing rights for most varieties are held by individual companies of the seed trade who subsequently contract seed production out to individual growers. Because the contracting company has a quota of acres for each of its proprietary varieties to fulfill its marketing targets, the grower often has limited choice in the variety to grow.

Kentucky bluegrass has been grown for pedigreed seed on 150-300 acres in Saskatchewan in recent years (1994-1996) accounting for 1-2% of the pedigreed grass seed acreage in the province. Dormie is the main variety multiplied for seed in Saskatchewan, although several other varieties are also grown for seed on a limited acreage. The average yield of Kentucky bluegrass is 125 kg/ac on dryland and 200 kg/ac under irrigation, but yields as high as 425 kg/ac have been harvested in Saskatchewan. Varieties differ widely in their potential seed yield.

II. Field selection

A. Adaptation

Kentucky bluegrass, which is best suited to a cool humid climate, requires more than 450 mm of annual precipitation and a mean July temperature less than 24°C. The temperature requirement is more critical than the precipitation requirement because the grass survives severe drought by entering dormancy. It prefers air temperatures between 15-32°C, but is one of the most cold hardy species.

Seed production of Kentucky bluegrass requires relatively dependable rainfall or irrigation to supply an annual precipitation of 450 mm of moisture for consistent seed yields. Irrigation is a requirement for contract pedigreed production of Kentucky bluegrass. Without adequate moisture, seed formation may be inadequate to justify the harvest of the seed crop.

B. Freedom from weeds

Quality standards for the turf seed market are very strict. The field selected for grass seed production must be free of noxious grassy and broadleaf weeds. A field may be left unattended for several weeks with only minimal weed growth and no appearance of quackgrass or Canada thistle only to have these weeds appear later. Noxious weed seeds in the sample disqualify the seed for market as pedigreed seed.

Weeds with similar size and shape of seeds to Kentucky bluegrass are extremely difficult to separate at the cleaning plant. Cleavers (bedstraw) is a troublesome primary noxious weed while stinkweed and wild oats are the main secondary noxious weeds. Chickweed, lamb's-quarters, timothy and wild barley are also difficult to separate at the cleaning plant. Another problem weed usually considered innocuous in annual crop rotations is native bluegrass. They will establish in seed production fields and are difficult to identify and rogue. Kentucky bluegrass for seed production must be sown on land free of these weeds.

Three applications of glyphosate over two to three years are required to control quackgrass. Pre-harvest glyphosate application at 1 liter per acre prior to sowing the grass greatly improves control of quackgrass, Canada thistle, and sow thistle. Quackgrass from the seed bank and dormant rhizomes will re-infest the field, so several years of control are essential to reduce the possibility of recontamination. A fallow or partial fallow period prior to seeding controls several flushes of annual broadleaf and grassy weeds. Prior to seeding the grass, weed control is easily achieved with broad spectrum herbicides and cultivation.

C. Freedom from herbicide residues

Kentucky bluegrass seedlings are sensitive to injury from soil residues of grassy herbicides. The residues of trifluralin herbicides (Advance 10G, Rival, Treflan) pose the greatest risk of herbicide injury for new seedings of grasses. These herbicides disappear from soil by volatilization. If these products have been applied at the maximum rate for oilseed or pulse crop production, grasses should not be sown for 24 months following a spring application or 30 months following a fall application. Fortress may also have some carryover residue if the volatilization of the herbicide is restricted by dry conditions. Kentucky bluegrass should not be sown in a rotation directly following a crop treated with Fortress.

Other products which have injured grass seedlings include Ally, Assert, Atrazine, Banvel, Glean, Princep/Simazine, Pursuit and Sencor. Many of the herbicides in this listing are only problems if used at high rates in the growing season prior to sowing the grass. Check the latest edition of Saskatchewan Agriculture and Food's Crop Protection Guide for current guidelines.

D. Pedigreed Requirements

There are three classes of pedigreed forage seed production in Canada: Breeder, Foundation, and Certified. Foundation seed is grown from Breeder seed and Certified seed is grown from Foundation seed. The seed must meet standards for germination, genetic purity, freedom from disease, and absence of the seed of weeds and of other crops. The Canada Seed Act specifies that seed must be pedigreed to be sold as a named variety.

The regulations for pedigreed status of seed are outlined in the Canadian Seed Grower Association Circular 6. In the year of seeding, the grower must notify the Canadian Seed Growers' Association of the pedigree of the seed planted and the area and previous cropping history of the production field. The field should be free of volunteer Kentucky bluegrass prior to seeding. Manure or other potentially weed contaminating material should not be applied to the field prior to seeding or during the productive life of the stand. Table 1 summarizes the regulations on the minimum cropping interval.

Table 1: Intervening crop seasons before re-cropping with Kentucky bluegrass as required by CSGA regulations

Class of seed sown	Class of seed harvested	Contaminating crop	Number of intervening crop seasons required
Breeder	Foundation	Non-pedigreed or different variety of Kentucky bluegrass	5 seasons
Breeder	Foundation	Same variety of Kentucky bluegrass	3 seasons
Breeder or Foundation	Certified	Kentucky bluegrass	2 seasons

A field sown with Breeder Kentucky bluegrass seed is eligible for four years of Foundation plus two years of Certified seed production. A field sown with Foundation Kentucky bluegrass seed is eligible for six years of Certified seed production. Two inspections are required annually for each pedigreed seed lot - a field inspection and a seed analysis. The production field must be inspected after the crop has headed, but prior to swathing or harvesting for each year that pedigreed seed is harvested. The seed lot must also be analyzed for weed and disease contamination and tested for germination. The identification tags from the seed bags must be retained for the life of the stand for presentation to the crop inspector.

Kentucky bluegrass is strongly apomictic. This means that the seeds are formed by without pollination. Isolation distances for this species are very short relative to requirements for cross pollinated

species of grasses. The isolation requirement depends on the class of seed produced as summarized in Table 2.

Table 2: Isolation distances required by CSGA regulations

Pedigree of Seed Produced	
Foundation	Certified
20 m	5 m
300 m	50 m

III. Crop establishment

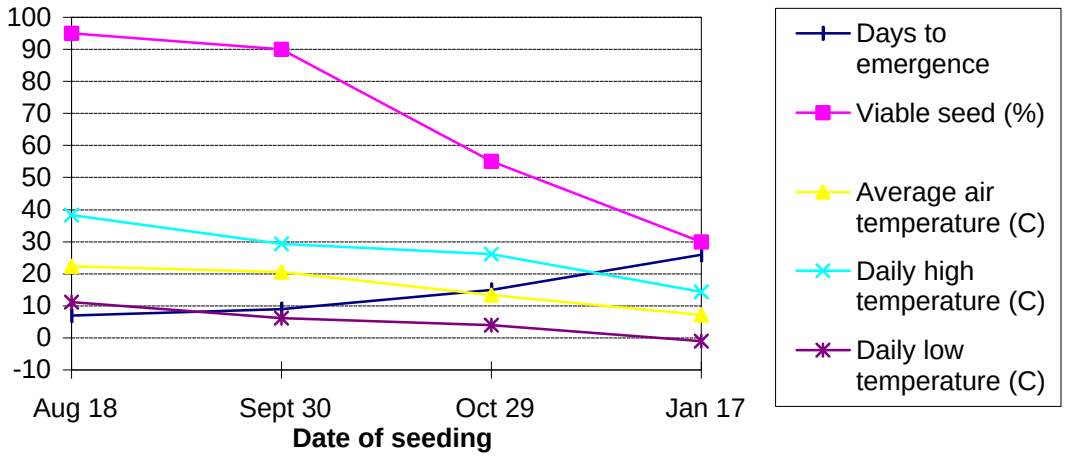
A. Seeding

The main objective for the establishment year is to produce a vigorous stand of healthy seedlings that have tillered profusely. Kentucky bluegrass may be sown with any conventional planting equipment if shallow seeding and adequate packing are achieved. Sowing no deeper than one-quarter inch with firm packing helps achieve maximum germination and rapid emergence of seedlings. As the seeding depth increases, the time required for the seedling to emerge increases and the percentage of seedlings that emerge decreases. The soil temperature will also play a major role in establishment (Figure 1). Aside from the length of day, conditions in Northern California in January are similar to Saskatchewan in May. Disc drills are the most common seeding implement. Zero-till seeding provides the firm moist seedbed into which the seed can be planted shallowly without difficulty. When zero-till seeding, ensure that there are options for controlling volunteer crop seedlings.

A firm seedbed is the most important requirement for shallow, even placement of grass seed. Packing after the last tillage operation helps firm the soil. Pulse crop rollers are an excellent way to level and to firm the soil prior to seeding. A rainfall following the final tillage operation will also firm and moisten the seedbed.

Planting into a “stale seedbed” is an effective method for establishing Kentucky bluegrass. The land is tilled, packed, leveled, and left to settle for two to three weeks.

Figure 1: Effect of soil temperature on germination and rate of emergence of Kentucky bluegrass in Northern California



Dew and one or two rains during the interim period firm the seedbed. A burn-off rate of glyphosate is applied just prior to or immediately after seeding with a disc press drill. The herbicide application effectively controls

weed seedlings and minimal disturbance prevents new weed growth. The seedbed remains firm and moist to the soil surface which is an excellent environment for germination and growth of new grass seedlings.

Applying this technique for planting into standing cereal stubble is an equally effective variation. The standing stubble provides protection from the wind, an ideal microclimate for establishment of the grass seedling. The anchored stubble also reduces the risk of erosion from heavy summer rains. Effective spreading of chaff and straw prior to seeding are essential for successful use of this technique.

Simple equipment modifications relieve many potential difficulties and minimize the risk of poor establishment. Packing wheels ahead of the disc opener levels the seeding surface and packs the soil. Depth control bands on discs maintain a shallow sowing depth and prevent overdeep seed placement. Packer wheels following directly behind the seeding disc provide good seed to soil contact.

The Kentucky bluegrass seed crop must be sown in May to harvest a satisfactory seed yield for the first harvest in the following year. With a delay in seeding, the first crop seed yield will be reduced, although subsequent crops often compensate for a smaller initial seed crop. Early seeding is important so that the seedlings can develop to sufficient size to be induced for seed production during the fall and early winter.

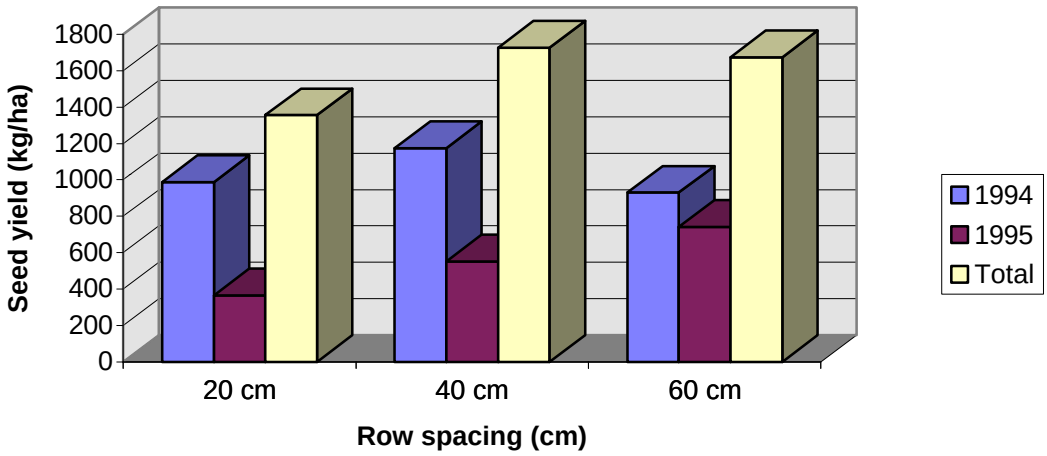
Kentucky bluegrass has a light chaffy seed that readily bridges in seed cups. Bridging causes inconsistent plant stands and missing seed rows. Agitators in the seed box prevent bridging and improve the flow of the light chaffy seed to the seed cups. If agitators are not available for your seed tank to disturb the grass seed, filling the seedbox only half full and getting extra help to mix the seed in the seedbox while planting will work. Polymer seed coatings improve the seed flow in the drill and protect the user from exposure to any seed treatments which may be added to control disease organisms. Carriers such as phosphate fertilizer (11-52-0) up to 15 lb P_20_5/ac, non-viable grain, or horticultural vermiculite clay may be mixed with the grass seed to help prevent bridging. Seed may also be mixed with phosphate fertilizer and “drilled” through the fertilizer attachment. Fertilizer will absorb hygroscopic moisture from the air over time and increase the moisture content of the seed. The increase in moisture content of the seed will decrease its viability. Seed mixed with fertilizer can be stored up to 3-4 weeks without injuring the seed germination as long as the mixture is stored under dry conditions.

B. Row spacing

Wide row planting of Kentucky bluegrass has several advantages. Planting in wider-spaced rows reduces the seed requirements, lowering input costs. As the stand ages, the plants can expand into the vacant area between the rows and maintain a higher seed yield potential. Although inter-row cultivation may stimulate new weed growth, tillage is easily performed with a row crop cultivator or gang rototiller. Weeds for roguing are easier to spot when the grass is sown in rows. Row production without irrigation also reduces the risk of seed yields reduced by drought. The ideal row spacing under irrigation is 30-35 cm (Figure 2). At wider row spacing, some weeds and shattered bluegrass seed will invade the stand if inter-row cultivation or timely herbicide application is not practiced.

The wide row spacings are easily accomplished with conventional equipment by placing tape over the unwanted seed cups in the seed box. Depending of the equipment, raising unwanted discs may also be possible. Some growers release the spring pressure on hoe drills so that the shoe just rides along the surface of the soil. With airseeders, blocking of outlets in discharge heads needs to be symmetrical to maintain uniform airflow. A wide range of modifications are easily accomplished depending on the type of equipment owned.

Figure 2: Effect of row spacing on seed yield of Kentucky bluegrass at Brooks, AB (Najda, 1996)



The seeding objective is to sow enough seed to achieve a satisfactory stand without too much inter-plant competition. Seedlings which are vigorously tillering will produce a higher seed yield. Because the weather is an important factor in the establishment of a seeding, the safe approach is to seed at a higher rate than is suitable for ideal conditions. It is wise for inexperienced growers to plan for loss of up to 80% of the seedlings. For Kentucky bluegrass, the seeder should be calibrated to sow 120 seeds per foot of seed row for 30 cm row spacings. When another material is mixed with the seed to eliminate bridging, the seeds per foot method of drill calibration eliminates guesswork. Kentucky bluegrass, on average, contains 2.2 million seeds per pound, but seed size among different varieties varies considerably. For a row spacing of 12 inches and a seeding rate of at least 120 seeds/ft, one acre (43,560 ft^2) contains 43,560 feet of seed row and requires 5.2 million seeds or about 2.4 lb seed/ac. The drill is easily calibrated by seeding over a sheet of plywood or a pad of concrete and counting the seeds sown over a measured distance.

C. Fertility

The soil fertility of the seed field should be determined by soil analysis prior to sowing. When sowing Kentucky bluegrass for seed production on fallow or partial fallow, soil reserves of nitrogen are likely adequate to carry the grass until the first fall after seeding. When stubble fields are sown prior to June 1, 20-40 lb N/ac should be applied to dryland fields and 50-80 lb N/ac to irrigated fields. A fall application of 30 lb N/ac to establishing seedling fields will promote maximum seed production in the first seed crop.

Phosphorus and potassium fertility is best corrected prior to establishment of the crop. Phosphorus enhances the growth rate and vigour of the seedlings. Yield responses of grasses to applications of phosphorus and potassium are seldom economical once the stand is established. Fields deficient in phosphorus and potassium should be fertilized at relatively high rates such as 100 lb P_20_5/ac and 100 lb K_20/ac banded prior to sowing the grass. A soil testing less than 35 lb P/ac needs phosphorus fertilization while a soil testing less than 200 lb K/ac needs potassium fertilization. Sulphur levels will be adequate if the field has been adequately fertilized with sulphur for optimum canola production within the last two years. Response

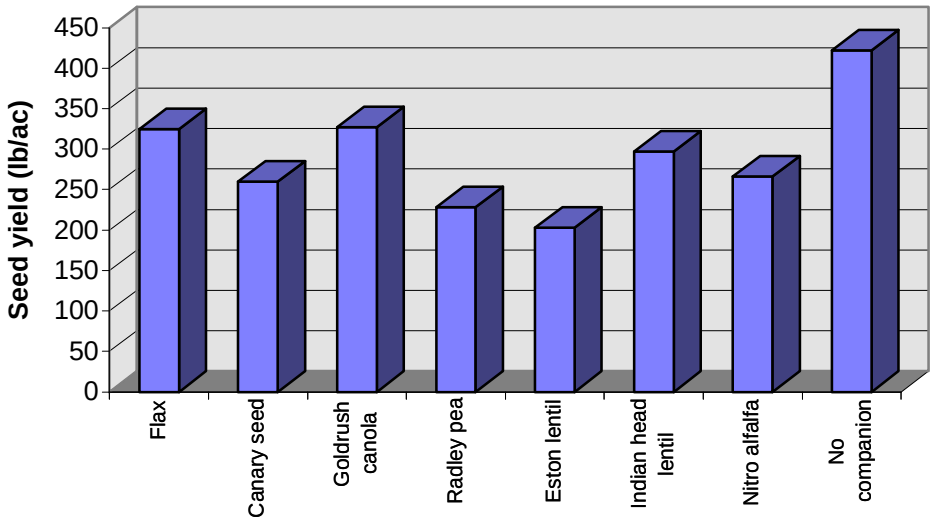
of Kentucky bluegrass seed yields to application of micronutrients has not been documented on the prairies, but response to copper deficiency has been reported in central Alberta.

The quantity of fertilizer which is safely placed in the seedrow with the grass seed is dependent on a number of factors. The organic matter and clay content of the soil, the moisture content of the soil at seeding, the time interval between seeding and the first precipitation after seeding, the row spacing, and the seedrow width affect the risk of seedling injury. As the content of organic matter and clay increase, risk of fertilizer injury to grass seedlings decrease. A soil moisture content near field capacity reduces "fertilizer burn" of seedlings. Rainfall immediately after seeding replenishes soil moisture and removes fertilizer salts from the vicinity of the seed. For a constant rate of fertilization, as the spacing between the rows widens, the amount of fertilizer next to the seeds increases. A narrow width of the seedrow itself will also place more fertilizer in close contact to the seed. The general guideline for forage seeds is for no nitrogen, potassium, or sulphur fertilizers placed in the seedrow. Application of phosphate fertilizer up to 15 lb $P_2 0_5$/ac is generally safe.

D. Companion crop

Seed production of Kentucky bluegrass is higher when sown without a companion crop (Figure 3). Kentucky bluegrass seedlings emerge slowly and are not very competitive. They will grow larger and tiller more during the establishment year when sown without a companion crop. Although the companion crop provides revenue during the establishment year, the yield of the first grass seed crop is usually reduced and offsets the benefit of the companion crop. By sowing the companion crop on a wider row spacing at a reduced rate, competition of the companion crop with the establishing grass seedlings is minimized. The least competitive companion crops were flax and Polish canola.

Figure 3: Effect of companion crop on seed yield of Kentucky bluegrass at Outlook, SK (Irvine, 1994)



IV. Crop Management

A. Weed control

Weed control options are limited once the Kentucky bluegrass is sown. Selective control of many broadleaf weeds is possible within the grass seed stand, but risk of reduced quality can be avoided and weed control measures simplified if these weeds are controlled before the crop is sown. Weeds also compete with the young Kentucky bluegrass seedlings, reducing their vigour and the yield potential of the stand.

Herbicide applications play an important role in the production of quality grass seed. Typical herbicide requirements during the seedling year for crops sown in the spring include late spring application of wild oat and broadleaf herbicide followed by a second broadleaf herbicide in fall. The spring application in the seedling year is often replaced by mowing to prevent seed set of weeds, especially if weed populations are thin. A broadleaf herbicide (and wild oat if required) is sprayed in early spring of the first seed crop. Check the latest edition of the Crop Protection Guide published by Saskatchewan Agriculture and Food for new registrations of herbicides for grass seed crops.

Clipping or mowing is another effective strategy for controlling annual weeds. The weeds should be mowed as required to prevent them from setting seed. After the grass crop becomes established, weeds will only germinate in the inter-row space during seed production years.

Field roguing is a requirement for production of quality grass seed for the Canadian market. Primary noxious weeds such as quackgrass, Canada thistle, cleavers, and wild mustard must be removed from the stand. Selective herbicide control for quackgrass in Kentucky bluegrass is not available in Canada. Quackgrass can only be removed from the field after sowing by spot spraying glyphosate with a backpack sprayer or hand roguing. Native bluegrass which volunteers in the stand must also be rogued out of the stand. Unthreshed wild mustard seeds lodge in the beak of the seed pod and this broken remnant of the pod cannot be removed because of its similar size to Kentucky bluegrass seed. Secondary noxious weeds such as wild oats, Persian darnel, scentless chamomile, shepherd's purse, stickseed (bluebur), and stinkweed are tolerated in small numbers, 4-10 in 25 g; however, some market standards are more stringent than Canada Seed Act standards. Certain seeds are very difficult to separate and must be eradicated in the field.

The seed grower must be vigilant to prevent re-introduction of weeds to the field. Native and volunteer bluegrass seeds will germinate within the stand. Crowns and rhizomes from previous perennial grass crops in the rotation will re-establish in seedling stands. Weed or crop seed in irrigation water or on equipment are one source of contamination when deposited within the field.

B. Disease and insect monitoring

Disease and insect problems in Kentucky bluegrass seed fields occasionally lead to significant seed yield losses. The most common problem is silvertop to which varieties of bluegrass differ in their susceptibility. Silvertop reduces the seed yield by prematurely halting development of the seed head. The head emerges from the stem, but turns white when the supply of water and nutrients is cut off. Insects puncture or feed on the stem above the top node and a fungal infection often develops near the point of injury. The end result is a conspicuous white seed head with no seed. Sweeping for insects in early spring provides an early warning for some causes of silvertop. The incidence of silvertop usually increases as the stand ages. If silvertop affected more than 10% of the seed heads in the previous year, spraying with dimethoate prior to boot stage of the grass is recommended as a preventative treatment for silvertop.

Powdery mildew, rust, and ergot also threaten to the yield potential of Kentucky bluegrass. Powdery mildew develops in spring and autumn under cool (15-22^{o}C), humid and cloudy conditions. An appropriate fungicide should be applied if the infestation comes early in the season. Leaf rust appears in late June as light

brown flecks on the leaf blades. Fungicide application is seldom necessary because the disease generally develops too late in the growing season to reduce seed yields in most areas of the Canadian prairies.

Ergot, a seed borne disease, is usually minor in Kentucky bluegrass seed crops. Ergot is indicated by collection of a sticky honeydew on the surface of infected florets during flowering or the presence of large black fungal structures that replace individual seeds in the mature seed head. Ergot is controlled by sanitation and by use of ergot-free seed. Seed cleaning is able to remove most of the ergot bodies from the seed lot. Storing the seed for a full year prior to using it reduces the viability of the ergot bodies. Field burning will reduce the survival of ergot bodies and provides some control of leaf spot diseases. Mowing of field edges will reduce infection from adjacent areas.

C. Irrigation management

The annual water requirement of Kentucky bluegrass is 350-400 mm . About 250-300 mm are required from spring thaw until harvest with an additional 50-100 mm required following harvest until freeze-up. The most critical period of water demand is during and after flowering. Plants stressed for moisture at this time develop blasted flowers or shriveled seed. Other symptoms of moisture stress are wilted leaves which fold along the mid-rib and a dull, darker green colour.

The effective rooting system of a Kentucky bluegrass seed stand is about 50 cm. The water holding capacity of the soil will determine the amount of water available to the growing crop. The objective for irrigation of Kentucky bluegrass is to maintain the rooting zone above 50% depletion of available moisture. During the early growing season, irrigation should be small and frequent, i.e. 20 mm per irrigation. As the crop nears stem elongation, the period between irrigation needs to be shortened to supply the increasing daily evapotranspiration. Because of the shallow root system of Kentucky bluegrass, the water application per irrigation should not exceed 25 mm.

Pollination lasts 10-14 days. During flowering, the crop needs to be well supplied with water, yet irrigation during pollination can damage the flowers. Just prior to pollination, the root zone should be irrigated to field capacity to reduce the need for irrigation during pollination. Water should be applied during this time only if the soil is nearing 50% depletion of available moisture. Once release of pollen has stopped, irrigation should be resumed for ten days to two weeks.

Water requirements after flowering are about 125 mm. During this period the soil should gradually dry out. Some irrigation will be required as the requirement exceeds the moisture holding capacity of the top 30 cm of light and medium textured soils. The crop is ready for swathing about 30 days after maximum flowering. At the time of swathing, available soil moisture should be depleted to 25-40% to minimize regrowth until the crop is combined and the straw and residue is removed.

The fall growth forms next year's seed crop. By August 15, the crowns and roots should have adequate moisture supply so that they can replenish reserves for spring growth. As soon as harvest and residue management is complete, fall nitrogen and enough irrigation to leach the fertilizer into the top foot of soil should be applied. New tillers must develop for a minimum of two weeks in the fall to be large enough for effective induction.

V. Harvest

Kentucky bluegrass is ready for harvest in mid-July. Frequent inspection of the seed field is important to determine the best time to harvest the seed. Hot, dry weather shortens the ripening period while cool, moist conditions will delay seed maturity. Uniform application of irrigation water during the growing season promotes

more uniform ripening of the stand. The seed heads turn from green to a light straw colour as the seed matures. The crop is ready for swathing when the seed heads have lost their green colour and a few seeds shatter from the top of heads when firmly tapped on the palm of the hand. The seeds have about 28% moisture at this stage of maturity. The seed at the top of the head matures first with the ripening proceeding downward to the base.

The moisture content of the seed head is unreliable when determined with conventional grain moisture testers. Seeds should be stripped from representative seed heads. Remove any stem pieces from the sample.. Sample enough seed heads to collect a 50 g sample. After determining the wet weight, dry the sample in a conventional oven set at 80-100^{o}C until the sample reaches a constant weight (2-8 hours). The sample may also be dried in a microwave oven using relatively short heating intervals of 2-3 minutes on a medium power setting. Place a cup of water in the microwave with the sample to prevent the sample from catching fire at lower moisture contents. Record the dry weight of the sample. The moisture content of the sample is calculated using the following formula: % moisture = ((wet weight - dry weight) / wet weight) * 100.

The tip seeds start to shatter at the time swathing should be done. Swathing early in the morning or in the evening or at night when the air humidity is higher will reduce shattering losses. If more than a few acres need to be harvested, the windrowing should begin prior to seed shatter to prevent excess shatter losses before the crop is cut.

The goal during swathing is to lay the swath as wide and uniform as possible to promote rapid drying. The ideal swather for cutting Kentucky bluegrass is equipped with a 12-14 ft auger header with a wide opening (5 ft) for laying the swath. Draper headers are suitable for lighter stands of Kentucky bluegrass, but auger headers deliver a more uniform swath with less bunching. Kentucky bluegrass swaths are very dense and wet and take too long to dry if the crop is cut with a wide windrower. For heavy stands, a swather with a split cutting bar reduces jamming of the knife. Prior to cutting, the cutting bar should be checked to insure that all sections are sharp. Some growers have two cutting bars so that one set can be repaired while the other is operating in the field. If the heads are laid in the center of the swath instead of to the side, some of the shattered seeds will be retained on the top of the swath. The crop continues to grow while the swaths lay in the field so a short harvest is important to maintain the productivity of the crop covered by the swaths.

The Kentucky bluegrass is ready to thresh 7-10 days after swathing once the seed is less than 12% moisture. Because of the potential for contamination and the value of Kentucky bluegrass, thoroughly clean the combine before threshing bluegrass. Initial settings for the combine are a high cylinder speed with a narrow concave opening and low fan speed. One to three filler blanks can be added to the concave to increase the aggressiveness of the cylinder. Some combines may separate more seed if equipped with a kit to slow the fan speed. The seed sample will contain a fair amount of chaff if the combine is set correctly. Rotary combines chop up the material more than conventional combines. Rotary threshed bluegrass will contain about 30% chaff while conventional threshed bluegrass will contain only about 15% chaff. If the sample is cleaner than these levels, considerable amounts of seed are likely passing out the back of the combine. Maintain an even flow of material into the combine. Kentucky bluegrass often requires a slower forward speed than wheat to improve separation of the seed from the chaff and straw. The air flow needs to be high enough to lift the chaff about 10 cm at the front of the sieve so that the seed can be separated from the chaff on the sieve. Watch for plugging of the return elevator when harvesting chaffy seed samples. Some growers combine their windrows a second time after a few more days of drying because it is very difficult to thresh all the seed from the stem in one pass.

Handling Kentucky bluegrass once the seed is in the combine hopper can be frustrating and slow. The seed of most varieties contains a tuft of fiber at its base which limits the flow of the seed. Some growers remove some covers over the unloading augers to reduce plugging problems. Many growers prefer to transfer the seed from the combine to holding crates or mini-bulk bags. Conveyor belt elevators and skid-steer front-end loaders are better suited for the transfer and handling of Kentucky bluegrass than augers. Large diameter augers will handle bulky grasses with less plugging. In the grain bin, the seed is more easily handled with a pitchfork than with a shovel. The seed can be stored safely in storage bins up to one year when the moisture content is 10-12%. Mold growth and insect damage may still occur at this moisture content. The safe moisture content for storage of grasses for longer periods is 8-10%.

Drying of grass seeds must be conducted with care to maintain the viability of the seed. When the seed has a high moisture content, the temperature of the air flow must be lower to prevent injury to the germination of the seed. The resistance of the seed to germination injury from high temperatures increases as the moisture content of the seed decreases.

VI. Post harvest management

Two fall management practices of Kentucky bluegrass which are critical to sustaining seed yield potential are stubble management and nitrogen fertilization.

A. Stubble management

Management of the stubble of Kentucky bluegrass seed fields depends somewhat on how quickly the harvest can be completed and the amount of regrowth that has occurred since swathing. If the harvest will be completed prior to August 15, the straw should be uniformly spread over the field and burnt as soon as the combine is out of the field. Be sure to consult the Field Burning Guide available from Alberta Agriculture or the Agriculture Canada Research Station in Saskatoon. Once this target date has passed without completion of harvesting, the straw should be left in windrows and baled. The remaining stubble should be clipped as short as possible with a mower or disc bine and removed by baling or ensilaging. Once September 1 has passed without completion of these operations, the field should be clipped with a swather as short as possible. The windrows should be removed as soon as possible. Grazing with sheep is a feasible alternative to clipping, but some caution is required to prevent noxious weed seeds from previous feed being deposited on the seed field.

B. Nitrogen management

Nitrogen increases the seed yield of Kentucky bluegrass by promoting growth of tillers and by stimulating the growth of larger seed heads in those tillers which will form seed heads. Tillers must have grown enough to be induced to form seed heads by the correct daylength and temperature for each species. The period of the year when this physiological change occurs differs among grass species. The period when tillers are induced to form seed heads and when the new seed head starts to grow may occur very close together or may be separated by several months. Adequate nitrogen fertility is essential when these two important processes occur. Kentucky bluegrass tillers are induced to develop seed heads in late autumn and begin development of these seed heads in early spring. Application of 20-25 lb N/ac just prior to the first fall irrigation in mid to late August will stimulate development of as many large tillers as possible. Application of an additional 100-175 lb N/ac depending on the variety of bluegrass and the age of the stand should be completed between September 15 and October 1 depending on the progress of the regrowth. The application should be delayed until just before freeze-up if the grass grows over 10 cm. Older stands require more nitrogen to reach

maximum seed yield. Fall applications of phosphorus and potassium according to soil test levels are also recommended.

The form of nitrogen applied to grass seed fields has a major impact on the seed yield response when applied with a broadcast spreader. The best nitrogen source for broadcast application is 34-0-0 (ammonium nitrate). This form is highly soluble in water and readily moves with soil moisture to plant roots for rapid uptake into the plant. Ammonium nitrate is not vulnerable to volatilization and is less prone to adsorption by stubble residues in the field. Liquid nitrogen is another excellent N source especially if dribbled under cloudy cool conditions or applied by spoke wheel injection. Because grasses efficiently absorb water from the soil, risk of leaching or denitrification is minimal. The ammonium nitrogen in urea (46-0-0) or even ammonium sulphate (20-0-0-24) is not only less accessible to the plant but also more vulnerable to loss by volatilization. If the application can be timed just prior to a significant precipitation event, any N form will be equally effective.

VII. Stand removal

Kentucky bluegrass is relatively easy to take out of rotation with glyphosate application. The crop should be cut as high as possible during the last harvest season to leave as many leaves available to absorb glyphosate. Glyphosate applied at 1-2 liter/ac on the green growth will provide fair control. The stand can then be broken with tillage with a lower fuel requirement. Some regrowth of the grass is likely during the subsequent growing season. If a broadleaf crop is sown the following spring, several graminicides are available to control regrowth of volunteer Kentucky bluegrass during the growing season.

VIII. Additional references

Canadian Seed Grower's Association. 1994. Regulations and procedures for pedigreed seed crop production. Circular 6-94. Ottawa, Ont.

Smith, S.R. 1996. Pedigreed forage seed production. Can. Seed Growers' Association, Ottawa, Ont.