Intermediate Wheatgrass Seed Production: A Literature Review

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I. Introduction

Intermediate wheatgrass, Agropyron intermedium (Host) Beauv. is a short-lived sod-forming grass introduced to Canada in the 1930's via the United States (Smoliak, 1981). The grass is native to central Europe, the Balkans, and Asia Minor, but has been grown for seed production in Saskatchewan since the 1960's. Production peaked in 1988 when over 1 million pounds were harvested. Recent production has been less than 500,000 pounds (Murrell, 1995). Utilization of the seed as an adjunct to flour mixes holds potential for increasing demand for the seed.

The plant produces erect stems with a heavy growth of erect basal leaves. The foliage varies in color from bright green to a dull blue green depending of the variety grown. Established plants start growth relatively late in spring, but grow quickly to a height of 1 - 1.5 meter at maturity and produces seed in spikes 15-25 cm long (Smoliak, 1981).

Pedigreed seed production of intermediate wheatgrass must follow the guidelines for isolation distances and cropping history. Two inspections are required annually for each pedigreed seed lot. The production field must be inspected prior to harvest and the seed must be inspected after harvest. The seed must meet standards for germination, genetic purity, freedom from disease, and absence of the seed of weeds and of other crops. The production of the seed must be pedigreed to be sold as a named variety. The pedigree guarantees to the purchaser the characteristics of the named (Canadian Seed Growers' Association, 1994).

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. Production of a Registered class of a intermediate wheatgrass variety is permitted when requested by the breeder of the variety to supply adequate quantities of seed for poor seed yielding varieties. In most cases, the Registered class applies to varieties developed outside Canada. The identification tags from the seed bags must be retained for the life of the stand for presentation to the crop inspector (Canadian Seed Growers' Association, 1994).

Pedigreed intermediate wheatgrass seed was grown on 1000 acres annually in Saskatchewan from 1994 - 1996. This area represents less than 10% of the pedigreed grass seed acreage in the province. Chief and Clarke were the main varieties harvested for seed. Another type of intermediate wheatgrass, pubescent wheatgrass, has very similar appearance and botanical features, except for short, stiff hairs on the heads and seeds (Smoliak, 1981). Greenleaf is the only variety of pubescent wheatgrass multiplied in Saskatchewan.

II. Field Selection

A. Adaptation

Intermediate wheatgrass is adapted to well drained, fertile soils with ample moisture (greater than 375 mm), but is not very tolerant to drought, salinity and waterlogging (Cooke, 1970). The grass is weakly to strongly rhizomatous depending on moisture conditions, but tolerates high lime soils very well. The species behaves like a bunch grass under dryland conditions, but is an aggressive sod-forming species under irrigation. The grass is vulnerable to winterkill following dry falls. Pubescent wheatgrass, the relative of intermediate wheatgrass, is more tolerant of drought, but is otherwise very similar in its habit (Smoliak, 1981).

Seed production of intermediate wheatgrass is better suited to the Dark Brown, Black and Gray soil zones. Because the grass is susceptible to drought, seed production is better suited to heavier soil textures. Excellent seed production on lighter textured soils requires relatively dependable precipitation (Atkins and Smith, 1967).

B. Freedom from weeds

The field selected for grass seed production must be free of noxious perennial grassy and broadleaf weeds. A clean weed-free field may be left unattended for several weeks with only minimal weed growth without any appearance of quackgrass or Canada thistle. Presence of noxious weed seeds in the sample disqualifies the seed for market as pedigreed seed. Special weed concerns for pedigreed intermediate wheatgrass seed production include wild oats, quackgrass, and other grasses. Because these seeds cannot be separated from the seed of intermediate wheatgrass, it is imperative to sow intermediate wheatgrass for seed production on land which is free of these weeds or to remove these plants from the field by application of appropriate herbicides or roguing. The presence of other weeds are also detrimental to the yield potential of the stand. Heavy weed pressure will weaken and may eliminate the new seedling from the stand (Dodds et. al., 1987).

Prior to seeding the grass, weed control is easily achieved with broad spectrum herbicides and cultivation. Weed control options become severely limited once the intermediate wheatgrass is sown. The only remaining option for many weeds may be roguing by hand or with a backpack sprayer within the stand which is very time consuming and costly.

Achieving this degree of sanitation may require one to two years of planning. Eradication of quack grass is essential prior to seeding any grass. Glyphosate application at 1-2 liter per acre in the fall prior to sowing the grass will control perennial weeds such as quackgrass, Canada thistle, and sow thistle. A fallow or partially fallow field provides opportunity to control several flushes of annual broadleaf and grassy weeds prior to seeding.

C. Pedigree Requirements

The selected field must have an adequate cropping interval between the seeded crop and a previous crop of the same kind. Intermediate wheatgrass planted with Breeder seed for Foundation status must be grown on land which did not grow a non-pedigreed crop of intermediate wheatgrass or a crop of a different variety of intermediate wheatgrass for any of the preceding five crop seasons. Intermediate wheatgrass planted with Breeder seed for Foundation status must be grown on land which did not grow the same variety of intermediate wheatgrass for the previous three crop years. Intermediate wheatgrass planted with Breeder or Foundation seed for Registered status must be grown on land which did not grow intermediate wheatgrass during any of the previous three years. Intermediate wheatgrass planted with Breeder or Foundation seed for Certified status must be grown on land which did not grow intermediate wheatgrass for the previous two years. Manure or other contaminating material should not be applied to the field prior to seeding or during the productive life of the stand (Canadian Seed Growers' Association, 1994).

The grower must notify the Canadian Seed Growers' Association in the year of seeding of the pedigree of the seed planted on the production field and the area and previous cropping history of the production field. A field inspection is required each year that a pedigreed seed crop is to be harvested. The inspection should be completed after the crop has headed, but prior to swathing or harvesting. A field sown with Breeder intermediate wheatgrass seed is eligible for three years of Foundation plus three years of Certified seed production. A field sown with Foundation intermediate wheatgrass seed is eligible for six years of Certified seed production (Canadian Seed Growers' Association, 1994).

Intermediate wheatgrass is cross-pollinated by wind and occasionally by insects. To maintain genetic purity, adequate isolation from other sources of pollen must be observed. For fields larger than 5 acres in size, Foundation, Registered and Certified seed crops must be separated from other intermediate wheatgrass by at least 300 m, 100 m, and 50 m respectively. Longer isolation distances are required when the field size is less than 5 acres. The requirement for these smaller fields increases to 400 m, 300 m, and 150 m for Foundation, Registered and Certified status, respectively (Canadian Seed Growers' Association, 1994).

D. Soil fertility

Soil fertility of the grass seed field should be evaluated. The easiest time to address phosphorus and potassium fertility problems is prior to sowing. Yield responses of intermediate wheatgrass seed to applications of phosphorus and potassium are seldom economical once the stand is established. Correction of phosphorus and potassium deficiencies prior to seeding will enhance the growth rate of the seedlings and improve the vigour of the young plants. The rate of fertilizer which may be placed safely in the seed row of forage grasses is minimal. Dryland fields which are deficient in phosphorus or potassium should be fertilized at relatively high rates such as 50 kg P205/ha and 50 kg K20/ha prior to sowing the grass. Nitrogen at a rate of 20-40 kg/ha should also be applied to stubble fields prior to sowing if the field will be sown before June 1. This is most important when the field is managed under zero tillage. When sowing the intermediate wheatgrass on fallow or partial fallow, soil reserves of nitrogen will most likely be adequate to carry the grass for the first seed crop. 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 intermediate wheatgrass seed yields to application of micronutrients is uncertain (Stoner and Horton, 1992) . The level of available nutrients, however, is easily checked by submitting a soil sample for analysis.

E. Moisture requirements

Seed yields of grasses vary with moisture conditions; therefore, irrigation or relatively dependable rainfall to supply 35-50 cm of moisture are essential for consistent grass seed yields. Without adequate moisture, seed head formation may be inadequate to justify the harvest of the seed crop. Under dryland, harvest of the grass as forage or pasture may be necessary in drier years to obtain revenue from a grass seed field when it has not set seed (Atkins and Smith, 1967).

F. Freedom from herbicide residues

Intermediate wheatgrass 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 volatization. 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. Intermediate wheatgrass should not be sown in a rotation directly following a Fortress treated crop (Sask. Ag. and Food, 1997).

Other products which have injured grass seedlings include Ally, Assert, Atrazine, Banvel, Glean, Princep/Simazine, Pursuit and Sencor (Sask. Ag. and Food, 1997). 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.

III. Crop establishment

Intermediate wheatgrass may be sown with any conventional planting equipment if shallow seeding and adequate packing are achieved. Although air seeder cultivators and hoe drills have successfully established intermediate wheatgrass, disk drills are the most common seeding implement. Some modifications to conventional equipment will simplify the seeding operation and reduce the risk of poor establishment. The addition of depth control bands to disks and agitators in the seed box relieve many of the difficulties associated with seeding intermediate wheatgrass. Zero tillage implements have also successfully established intermediate wheatgrass. A good grass seed drill has the following features:

1) a packing wheel ahead of the disk opener to level and firm the soil, (for tilled soil)
2) depth control bands on the disk opener to maintain shallow penetration
3) a trailing packer wheel to ensure good seed to soil contact
4) agitation in the seed box to prevent bridging of seed.

A firm seedbed is essential for shallow even placement of the seed. Packing following the last tillage operation will help to firm the soil. Some grass seed producers roll their fields before seeding to improve control of seeding depth. A rainfall following the final tillage operation will also prepare a firm and moist seedbed for placement of the grass seed.

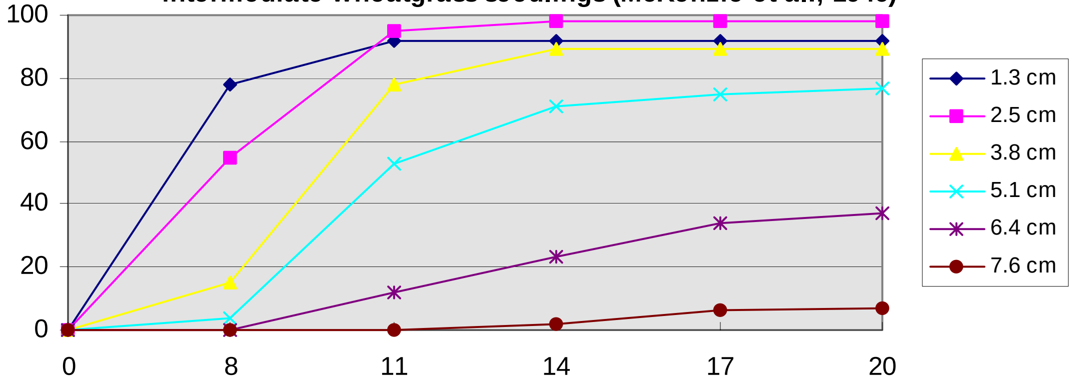
Intermediate wheatgrass has a relatively large seed, but chaffy seed samples of this species are still prone to bridging which causes inconsistent plant stands and missing seed rows. Agitators in the seed tank to disturb the grass seed will prevent bridging of the seed. Filling the seedbox only half full and getting extra help to mix the seed in the seedbox while planting overcome this difficulty if agitators have not been installed in the seedbox. Using seed coated with a polymer film will improve the flow of the seed in the drill and will protect the user from any seed treatments which may be added to control disease organisms. Another helpful approach is to mix an equal volume of low nitrogen fertilizer (12-51-0), cracked wheat, or cereal grain with the seed. Unused seed should be separated from the fertilizer as soon as possible after seeding is completed. 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. Senter et al. (1975) found that the germination of three grass species was reduced if the seed was in contact with a 20-20-0 blended fertilizer for more than nine days under humid conditions. Fertilizers with low water solubility can be safely mixed with intermediate wheatgrass seed for periods up to 3-4 weeks without injuring the germination of the seed if the mixture is stored under dry conditions.

The quantity of fertilizer which is safely placed in the seedrow with the grass seed is dependent on a number of factors. The texture and organic matter content of the soil are the two most important factors which limit the risk of injury. The moisture content of the soil at seeding time, the proximity of precipitation to the seeding operation, the spacing between rows, and the width of the seedrow itself are the remaining considerations. Soils with a high content of organic matter and clay have a lower risk for fertilizer injury to grass seedlings. A soil with a moisture content near field capacity is less likely to have fertilizer injury. Rainfall immediately after seeding will replenish the moisture content of the soil and remove fertilizer salts from the vicinity of the grass seeds. As the spacing between the rows widens, the amount of fertilizer next to the seeds will increase if the application rate per unit area remains the same. A narrow width of the seedrow itself will place more fertilizer in close contact with the seed than a slightly wider seedrow. 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 kg P205/ha is generally safe if the preceding principles are kept in mind.

Shallow placement and excellent packing of seed is important to achieve a high percentage of germination and emergence of seedlings. Although intermediate wheatgrass is more tolerant of deeper seeding than most grasses, shallow seeding does improve the vigour of the stand . As the seeding depth increases, the time required for the seedling to emerge from the ground increases and the percentage of seedlings that emerge decreases. McKenzie et al. (1946) found that intermediate wheatgrass emerged satisfactorily from depths down to 3.8 cm in a loam soil (Figure 1). Lawrence et al. (1991) observed that emergence of intermediate wheatgrass declined more quickly than the other wheatgrass and wildrye species tested. Surface seedings emerged well, but only 65% of the seeds sown at a depth of 2 cm emerged. Lawrence (1957) found that seed size of intermediate wheatgrass was related to neither emergence nor rate of emergence.

The main objective for the establishment year is to produce a vigorous stand of healthy seedlings which have tillered profusely. For sowing on well-prepared fallow or for zero tillage establishment, the best seed yields are often obtained with early spring seedings. Intermediate wheatgrass is sensitive, however, to planting in cold soils (McElgunn, 1974). For a temperature regime which alternates between 2oC and 13oC,

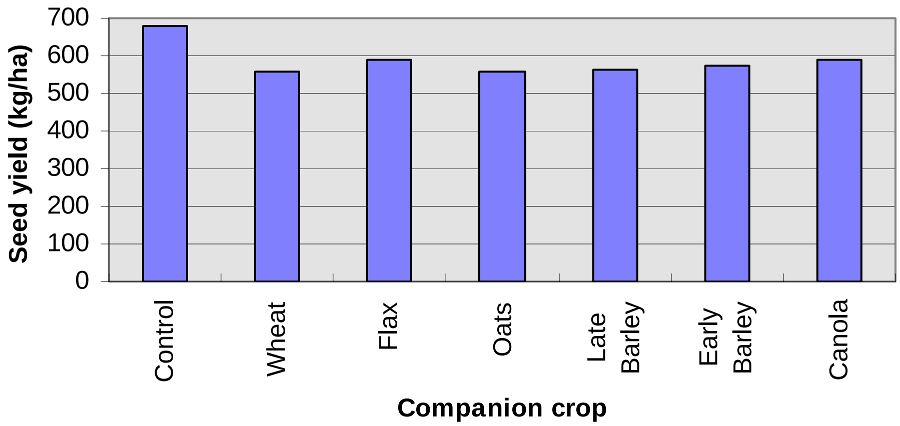
Figure 1: Effect of seeding depth on rate of emergence of intermediate wheatgrass seedlings (McKenzie et al., 1946)



the germination rate of intermediate wheatgrass was only three-quarters as high as for other warmer regimes. Delaying seeding until the minimum temperature has risen above 4oC may improve the germination of intermediate wheatgrass. The intermediate wheatgrass seed crop may be sown anytime between mid-May and late June, however, without much difference in seed yield. Although the first seed crop may be reduced with a delay in seeding, subsequent crops often yield more seed which compensates for the smaller initial seed crop. Research at Beaverlodge indicates that intermediate wheatgrass should be sown prior to June 30 for a satisfactory seed yield in the next year (Elliott and Howe, 1977).

Seed production of grasses is higher when no companion crop is sown with the grass seed. The seedlings grow more vigorously during the establishment year and are not stunted by the companion crop. Although the companion crop provides some revenue during the establishment year, the first seed crop of grass is sufficiently reduced to offset the benefit of the companion crop. Elliott and Howe (1977) found that seed yields of intermediate wheatgrass averaged over eleven harvest years were a minimum of 30 kg/ha/yr. higher when no companion crop was sown. Intermediate wheatgrass tolerated the presence of the companion crop relatively well without a major reduction in two of three seedings. Flax and canola had the least effect on seed yields of crops tested. Row planting of grass seed fields provides a number of benefits. Planting in wider-spaced rows reduces the seed requirements which reduces input costs. The stands can be tilled with a row crop cultivator or gang rototiller to control weeds. Seed yields will be higher, especially as the stand ages. Roguing of the field is more thorough and easier (Patterson, 1956). Row production of grass seed under dryland conditions reduces the risk of lower seed yields due to drought (Crowle, 1966; Knowles et al., 1969).

Figure 2: Effect of companion crop on seed yield of intermediate wheatgrass (Elliott and Howe, 1977)



Swaths are often difficult to pick up from between widely spaced seed rows. Cutting the crop at an angle across the seed rows may alleviate this difficulty. If inter-row cultivation is practiced, however, the field becomes too rough to swath the field across the seed rows. One alternative is to straight combine the crop. Another approach is to sow the field on a 90 cm row spacing and groups of three or four 30 cm row spacings placed where a windrow would be laid during swathing. The narrow-spaced rows provide the stubble to hold up the windrow. Inter-row cultivation is still possible in the wide spacing.

The seed yields of intermediate wheatgrass sown at four row spacings were determined at Saskatoon for four years. Seed yields were higher with 61 or 91 cm rows than for narrower row spacings (Knowles, 1961). Black and Reitz (1969) on dryland in Montana found that the average annual seed yield over five years decreased from 76 to 152 cm row spacing. A row spacing study at Nipawin, SK found that the average seed yield over three seasons was similar for row spacings of 45 to 90 cm. Narrower row spacings produced much lower seed yields over the three years (Newfield Seeds, 1993). Similar results were observed by Darwent et al. (1987). Seed yields per annum increased from 16 cm up to 104 cm. Differences were smaller for row spacings between 60 and 104 cm, but yields continued to increase as the row spacing widened.

Weed control during the establishment year can be accomplished in several ways. Competition with the weeds can be increased by sowing a cover crop with the grass. The weed species can also be controlled by judicious use of herbicides or by repeated mowing. Knowles (1961) found that mowing was more successful than either other method in terms of the seed yield from the treatments (Figure 5).

Figure 3: Effect of row spacing on seed yield of intermediate wheatgrass at Nipawin, SK (Newfield Seeds, 1993)

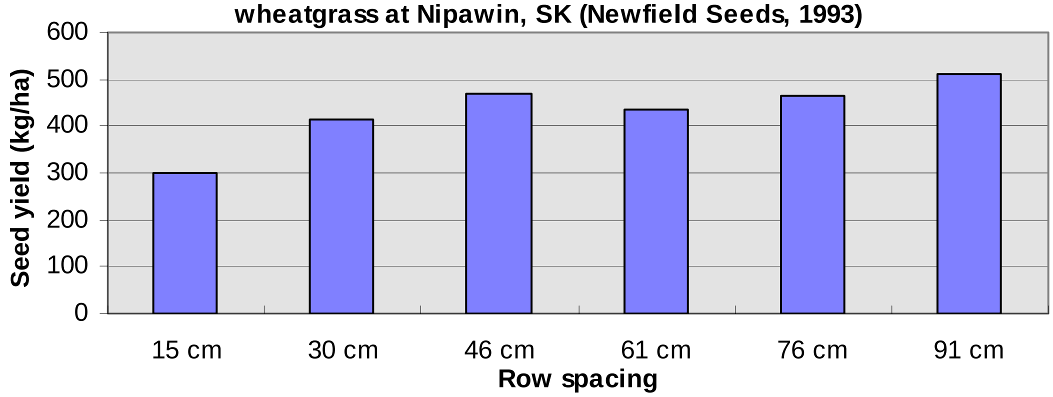


Figure 4: Row spacing effect on intermediate wheatgrass seed yield at Beaverlodge, AB (Darwent et al., 1987)

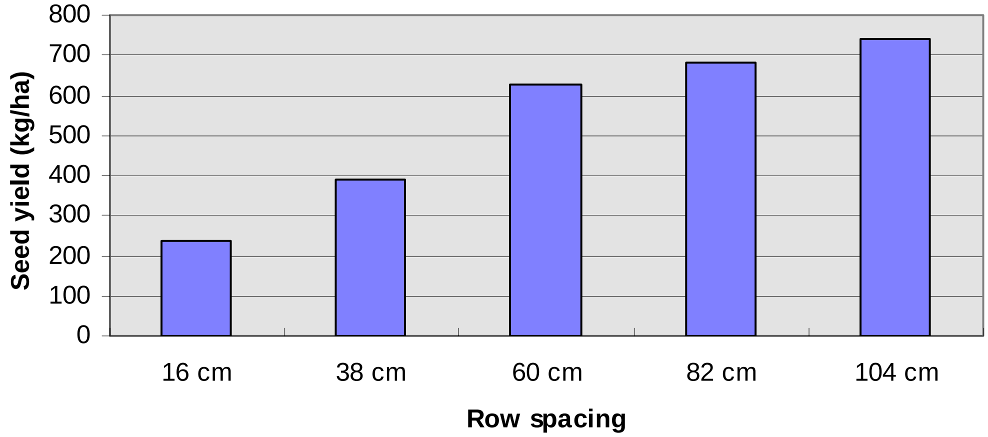
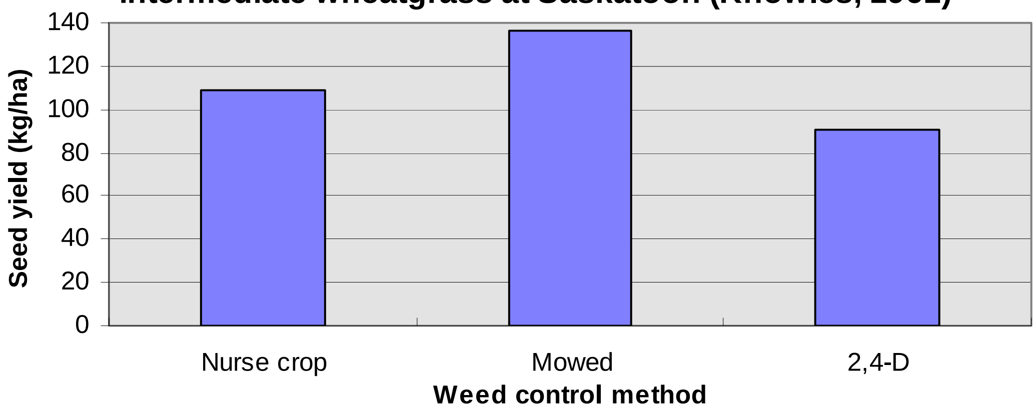


Figure 5: Effect of weed control method on seed yield of intermediate wheatgrass at Saskatoon (Knowles, 1961)



The sowing rate for grasses is somewhat arbitrary depending on the suitability of the soil for seed germination. Because the weather is an important factor in the success of a seeding, the safe approach is to seed at a higher rate than is suitable for ideal conditions. It is wise to plan for loss of up to 80% of the seedlings. The goal is to sow enough seed to achieve a satisfactory stand without too much inter-plant competition. Seedlings which are vigourously tillering will produce a higher seed yield. Button et al. (1993) recommend a seeding rate of 3.5 - 4.0 kg/ha with a 60 cm row spacing. Holzworth and Wiesner (1993) suggest 50 seeds per metre of seed row. When another material is mixed with the seed to eliminate bridging of the seed, this method takes much of the guesswork out of determining the drill setting. With a 60 cm row spacing, one hectare (10,000 m2) would contain 16,667 meters of seed row. Since one kilogram of intermediate wheatgrass contains 194,000 seeds (1 lb = 88,000 seeds), the rate for intermediate wheatgrass is 4.3 kg/ha (3.7 lb/ac). Using this approach, it is easy to calibrate the drill by seeding over a sheet of plywood or a pad of concrete and counting the seeds sown over a measured distance (Koturbash and Eagle, 1991).

The injury to germinating seedlings from fertilizer occurs from two sources: the dissolved salts and the ammonium content. Fertilizers which are readily soluble in water are more hazardous than less soluble forms. Nitrogen sources which liberate ammonium are more hazardous than nitrate sources. Ammonium phosphate is relatively safe because the fertilizer is dissolved more slowly when it comes in contact with moisture and the ammonium content of ammonium phosphate is only 10-12% of the weight of the fertilizer.

IV. Crop Management

Herbicide registrations for the control of weeds during the seedling year provide a wide array of options for control of annual grassy and broadleaf weeds. The most difficult weeds to control include quackgrass, downy brome, green foxtail, and Persian darnel. Controlling annual grasses during a seed production year reduces the need for roguing. Refer to Table 2 for currently registered treatments.

Clipping or mowing is another effective strategy for controlling annual weeds. The weeds should be mowed as required to prevent them from setting seed. When the soil is not disturbed, most weed seeds do not germinate. After the grass crop becomes established, few weeds will germinate in the seed production years.

Field roguing is a requirement for production of quality grass seed for the Canadian market. The chaffy grasses such as intermediate wheatgrass have no tolerance for primary noxious weeds such as quackgrass, Canada thistle, cleavers, and wild mustard. Wild oats, Persian darnel, scentless chamomile, shepherd's purse, stickseed, and stinkweed are secondary noxious weeds which are limited to 1 and 2 seeds in 25 g for Canada Registered No. 1 and No. 2 grades respectively. Any of these weeds which appear in the stand must be eradicated before the field is inspected. Although downy brome is not listed as a noxious weed, some customers will not purchase seed containing this weed. The weedy plants may be uprooted manually by hoe or hand-pulling. Roundup is an effective herbicide for controlling perennial weeds in grass seed stands, but it must be applied by spot treatment directly on the target weeds to prevent injury to the grass seed crop.

Adequate moisture for grass seed crops is important to sustain seed yields. Irrigation of intermediate wheatgrass at Scott, Saskatchewan with 370 mm increased the seed yield over five seed crops by an average of 207 kg/ha per annum. The average rainfall during the growing season was 210 mm (Crowle, 1966).

V. Disease and Insect Problems

Ergot infects cross-pollinated grasses such as intermediate wheatgrass. The disease is caused by the fungus Claviceps purpurea. The first symptoms of ergot infection are the collection of a sticky honeydew on the surface of infected florets. The deposit contains the spores of the disease. The fungus continues to grow within one or more of the infected florets to form a hard, purplish black ergot body in place of one of the seeds. Often the ergot body or sclerotium is conspicuous because it is black and much larger than the seed it replaces. Ergot-affected heads will produce few seeds. Often infected heads will contain no viable seed. Ergot tends to be spread from infected grasses along field margins. The disease is most prevalent during years when the soil surface is moist during the spring and early summer and when showers prevail during the flowering period of the grass. Moisture stimulates the germination of sclerotia and the release of the infecting spores. Wet cool weather also prolongs pollination which increases the likelihood of infection of florets by spores. Fertilized ovaries are resistant to ergot infection. Seed treatments are ineffective in control of ergot. Sanitation and use of ergot-free seed are the best control measures. Mowing the field edges just prior to heading reduces the risk of ergot infection. If the outside edge of the field is infected, this portion should be harvested and kept separate from the remainder of the seed. Storing the infected seed for three or more years will also reduce the number of viable sclerotia. The Canada Seed Act allows only 1.5% sclerotia in No. 1 seed and 3% in No. 2 seed (Seaman, 1980).

Silvertop damage to intermediate wheatgrass may cause substantial yield losses. The condition appears about the time of flowering as silvery-white heads which appear mature, but contain no seed. The flag leaf, sheath, and lower stem remain healthy and show no evidence of any growth problem. The inflorescence of the stem dies from stem injury at one or more points above the terminal node. A maggot may chew the stem, but an insect usually punctures the stem and the seed head turns white once the plant is exposed to an environmental stress. Several plant bugs are suspected agents for the condition: Stenodema, Irbisia, Capsus, Trigonotylus, and Labops (Soroka, 1991). The emerged inflorescence of affected stems is easily pulled from the leaf sheaths with the lower end often shrunken, darkened, necrotic, and infected with a fungal growth. The fungal growth is likely a secondary infection of the plant caused by Fusarium poae. Arnott and Bergis (1967) observed punctures through leaf sheaths opposite areas of stem injury in intermediate wheatgrass. The condition has been controlled in bluegrass by burning the grass field after harvest. Grazing the bluegrass field in the fall (Peterson and Vea, 1971) and mechanical removal of the straw (Kamm, 1979) did not control the condition in bluegrass. Schaber (1994) found that spring burning of intermediate wheatgrass fields reduced some insect pest populations.

VI. Harvest

Grasses need about 30 days after flowering for the seeds to develop. Hot, dry weather shortens the ripening period while cool, moist conditions will delay seed maturity (Tober, 1988). Grasses grown under irrigation or moister conditions have a higher ash content which increases the likelihood of shattering (Najda et al., 1994). The ripening process begins at the top of the seed head and proceeds down the stem. Seeds at the top of the head may begin to shatter while those at the bottom are only starting to fill seed. Frequent inspection of the seed field is necessary to determine when the maximum yield of seed will be harvested.

The appropriate harvesting approach depends on the seed size, plant height, maturity, shattering traits, seed head abundance, seed fill, and moisture content. Conventional harvest equipment is suitable for most grasses. Intermediate wheatgrasses are harvested by windrowing and picking the swath up after 4-7 days of drying or by straight combining (Tober, 1988). Intermediate wheatgrass is ready to swath in most years in mid to late August. Swathing and picking up the windrow is the safest harvesting approach, but in years of lower seed yield, earlier maturity, or reduced foliage, straight combining may be more appropriate. Intermediate wheatgrass has a moderate shatter risk relative to other grasses and seldom lodges unless very heavy rates of nitrogen have been applied and crop growth is very rank. The crop should be swathed when the moisture content is between 50-55% (Elliott, 1972). This corresponds to the medium to hard dough stage. This stage occurs when firm thumb nail pressure is needed to imprint the seed. The neck of the seed heads will be brown. If some seed shatters when striking the seed head firmly against the palm of the hand, the crop is ready to swath. The seed will have only a slight tinge of green. The top of the stem will snap between the fingers. Cutting the crop too early produces a high percentage of light chaffy seeds (Gross, 1970). Swathing early in the morning or in the evening when the air humidity is higher will reduce shattering losses. 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. Intermediate wheatgrass can grow relatively tall and form a very heavy swath. To limit the material passing through the combine as much as possible, the crop should be cut as high as possible while leaving the swath sitting on top of the stubble. Cutting the crop with a relatively narrow swather and laying a uniform swath will reduce the risk of plugging the combine.

Under good drying conditions, the crop will be ready to combine in 5-7 days after swathing. Initial combine settings recommended for intermediate wheatgrasses are a cylinder speed of 850 rpm and a concave clearance of 1/4". The fan speed is generally set between 350-400 rpm with the sliding covers over the exterior fan housing open about 2" (Tober, 1988). The combine should be set so that the hull is retained on the seed. Seeds with hulls have a higher germination and emergence percentage as compared to hulless seeds (Kilcher and Lawrence, 1960).

Because of the potential for contamination and the value of grass seed, thoroughly clean the combine before harvesting grass seed. Maintain an even flow of material into the combine. Grass seed crops often require a slower forward speed than conventional crops. Slower combining speeds improve the seed separation from the chaff and straw and greatly reduce losses over the straw walkers and sieves (Najda et al., 1994). Experienced intermediate wheatgrass seed producers rely more heavily on the seed processing plant to remove chaff and straw than the combine to reduce seed losses out the back of the combine. The seed can be stored safely in open storage 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 open storage of grasses for longer periods is 8-10% (Harrington, 1960).

Intermediate wheatgrass is ready for straight combining at the first hint of seed shatter. When the seed shatters as the seed head is lightly struck against the palm of the had, seed shatter is imminent and the field should be straight combined. This is usually about 10 days after the crop was ready for swathing. The seed will contain about 30% moisture. Because the seed will readily shatter at this moisture content, the risk of losing the crop from a wind storm is high. If the seed yield will be less than 100 kg/ha, straight combining is recommended. Seed that is direct combined will need immediate aeration and drying to maintain the quality of the seed. Many of the short stems that remain in the sample have a high moisture content which promote heating of the seed. Some grass seed growers install an aeration tube directly into their grain truck so that the seed can be easily aerated without dumping into a storage bin. Running the seed over a sieve to remove much of the green leaves, insects, chaff and straw will reduce the risk of heating in the direct combined seed. If the seed is left in a small pile for only a few hours, significant heating may still occur which reduces the viability of the seed. The heating is dependent on the moisture content of the seed, the air temperature, and the position of the seed in the pile. Air temperature is less important as the moisture content of the seed increases, but is significant at lower moisture contents (DeWitt et al., 1962).

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 maintained at a lower temperature 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. Drying grasses in bulk with near ambient air overcomes the problems of susceptibility to thermal damage and poor air flow characteristics. Walking on top of stored seed compacts the seed and reduces air circulation through the seed. To gain access to piles of stored seed, use of boards for walking is recommended.

VII. Post harvest management

Nitrogen application to intermediate wheatgrass seed fields is essential for sustained seed yields. Stoner and Horton (1992) observed a significant seed yield response to nitrogen applications up to 100 kg/ha at two sites in north-east Saskatchewan (Figure 6). The smaller seed yield response at the Eggerman site was likely due to the presence of alfalfa earlier in the rotation. Canode (1964) observed a significant increase in average seed yield up to 112 kg N/ha in Pullman, Washington. The nitrogen was applied annually in September following the first seed crop. On an annual basis, however, this experiment showed no response in seed yield to nitrogen for the third through fifth seed crops for applications over 66 kg N/ha.

Figure 6: Response of intermediate wheatgrass to spring-applied N in NE Saskatchewan (Stoner and Horton, 1992)

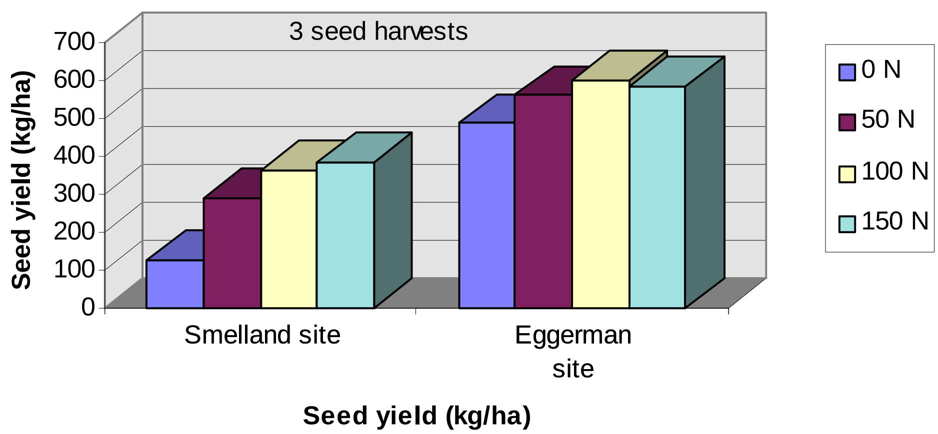
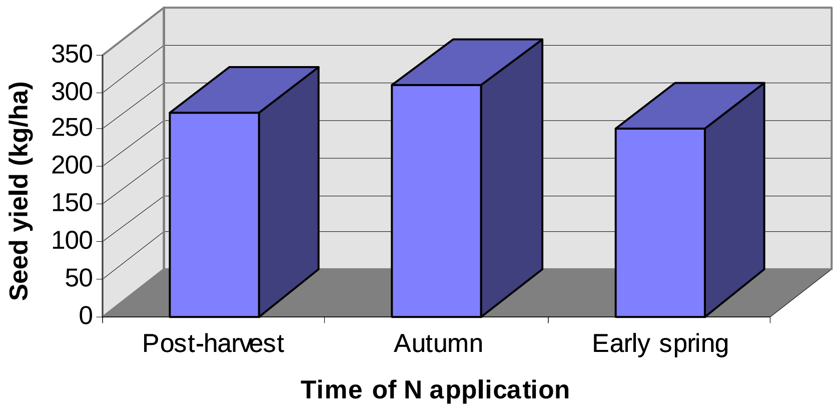


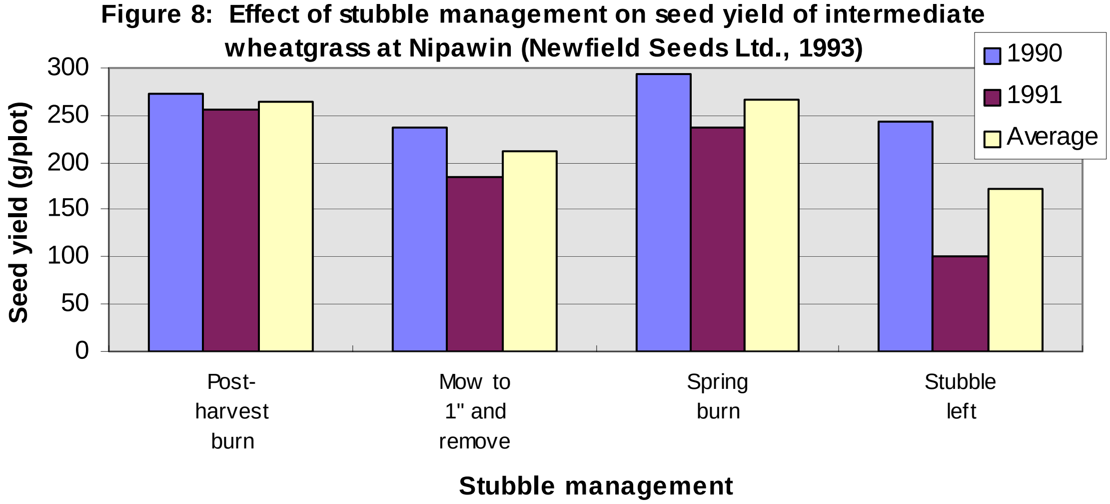
Figure 5: Effect of timing of N application on seed yield of intermediate wheatgrass (Horton, 1991)



Hennig and Elliott (1970) recommend that the best time for nitrogen application to grass seed crops is just prior to floral initiation. Elliott (1966) found that intermediate wheatgrass tillers were not induced until early November at Beaverlodge, AB. and that the majority of the induced tillers in intermediate wheatgrass undergo floral initiation by mid-May. Intermediate wheatgrass had completed floral initiation by May 13 at Beaverlodge, Alberta (Elliott, 1966). Horton (1991) observed higher seed yields of intermediate wheatgrass more consistently when nitrogen was applied in late fall as compared to after harvest and early spring applications (Figure 7). Spike initiation is delayed until May in intermediate wheatgrass, however, so application of nitrogen in spring will be effective in increasing seed yield if completed before late April.

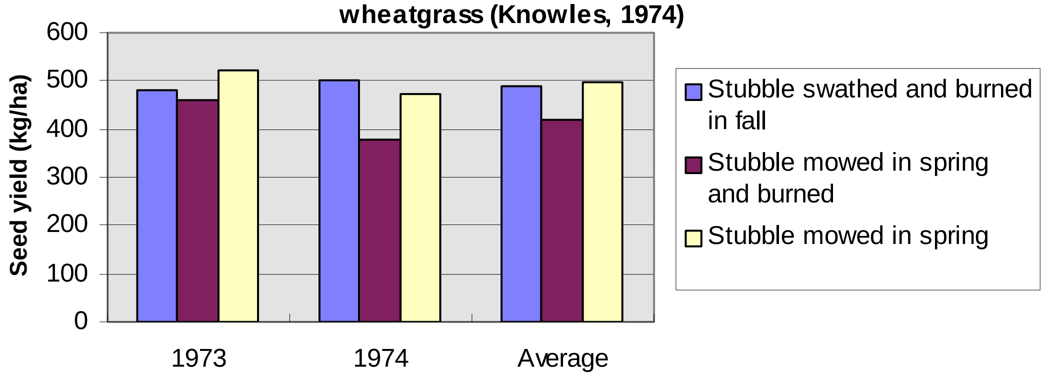
Canode (1964) evaluated the practice of removing stubble from intermediate wheatgrass seed production fields at Pullman, Washington. Burning the residue in September increased seed yields by 55 kg/ha relative to mechanical removal. Knowles (1974) observed higher seed yields for mechanical removal of the stubble in both fall or spring ad compared to burning in spring. Newfield Seeds (1993) found that the best seed yields were obtained with either a post-harvest or a spring burn. Schaber (1994) in

Figure 8: Effect of stubble management on seed yield of intermediate wheatgrass at Nipawin (Newfield Seeds Ltd., 1993)



Alberta observed a 60% seed yield increase by burning the crop residue in April as compared standing intermediate wheatgrass stubble. He attributed this yield increase to a reduction in insect activity and the fertility value of the ash.

Figure 9: Effect of residue removal on seed yield of intermediate wheatgrass (Knowles, 1974)



Canode and Law (1978) found that fall burning controlled downy brome in grass seed crops when the burn temperatures reached greater than 500 C. Although yields from removal of the stubble in fall by mowing or burning were comparable to yields when these practices were completed in spring, the stubble is useful for catching snow. From the point of view of moisture conservation and protection from winter injury, spring burning is preferable to fall burning.

<u>VIII. References:</u>

Arnott, D.A. and Bergis, I. 1967. Causal agents of silver top and other types of damage to grass seed crops. Can. Ent. 99:660-670.

Atkins, M.D. and Smith, J.E. Jr. 1967. Grass seed production and harvest in the Great Plains. U.S.D.A. Farmer's Bull. 2226. USGPO, Washington, DC.

Black, A.L. and Reitz, L.L. 1969. Row spacing and fertilization influences on forage and seed yields of intermediate wheatgrass, Russian wildrye, and green needlegrass on dryland. Agron. J. 61:801-805.

Button, R., Murrell, D., Stoner, K., and Pearse, G. 1993. Forage seed production guide - 1993. Sask. Ag. and Food, Tisdale, SK.

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

Canode, C.L. 1964. Influence of cultural treatments on seed production of intermediate wheatgrass (*Agropyron intermedium* (Host) Beauv.). Agron. J. 56:207-210.

Canode, C.L. and Law, A.G. 1978. Influence of fertilizer and residue management on grass seed production. Agron. J. 70:543-546.

Cooke, D.A. 1970. Intermediate wheatgrass. Agriculture Canada Research Station, Melfort, SK.

Crowle, W.L. 1966. The influence of nitrogen fertilizer, row spacing, and irrigation on seed yield of nine grasses in Central Saskatchewan. Can. J. Plant Sci. 46:425-431.

Darwent, A.L., Najda, H.G., Drabble, J.C., and Elliott, C.R. 1987. Effect of row spacing on seed and hay production of eleven grass species under a Peace River region management system. Can. J. Plant Sci. 67:755-763.

DeWitt, J.L., Canode, C.L., and Patterson, J.K. 1962. Effects of heating and storage on the viability of grass seed harvested with high moisture content. Agron. J. 54:126-129.

Dodds, D., Carter, J., Meyer, D., and Haas, R. 1987. Grass seed production in North Dakota. Publ. #R-917. North Dakota State University, Coop. Ext. Serv., Fargo, N.D.

Elliott, C.R. 1966. Floral induction and initiation in three perennial grasses. Ph.D. thesis, University of Saskatchewan, Saskatoon, SK.

Elliott, C.R. 1972. Grass seed production: Effect of seed moisture content and harvesting. Agri-science Field Crops Agdex 120.50. Northern Research Group, Ag. Can., Beaverlodge, AB.

Elliott, C.R. and Howe, M. 1977. Grass seed yield data - 1969-1977. Northern Reserch Group Publ. #77-14. Agriculture Canada Research Station, Beaverlodge, AB.

Gross, A.T.H. 1970. Intermediate wheatgrass in Manitoba. Publ # 343, Manitoba Dept. of Agriculture, Winnipeg, MB.

Harrington, J.F. 1960. Thumb rules of drying seed. Crops and Soils 13(Oct.):16-17.

Hennig, A.M.F. and Elliott, C.R. 1970. Fertilizing grasses for seed production. Leaflet #11. Northern Alberta Research Station, Beaverlodge, AB.

Holzworth, L.K. and Wiesner, L.E. 1993. Principles of establishment and seedling year management, pp 170-228. In Baldridge, D.E. and Lohmiller, R.G. Interagency plant materials handbook for forage production, conservation, reclamation and wildlife. Mont. State Univ. Ext. Serv. Bull.#EB69.

Horton, P.R. 1991. Increasing forage seed production with fertilizer. Agr. Dev. Fund, Regina, SK.

Kamm, J.A. 1979. Plant bugs: Effects of feeding on grass seed development; and cultural control. Env. Entomol. 8:73-76.

Kilcher, M.R. and Lawrence, T. 1960. Quality of intermediate wheatgrass seed, with and without hulls. Can. J. Plant Sci. 40:482-486.

Knowles, R.P. 1974. Effect of residue removal in reed canarygrass and intermediate wheatgrass seed plots. Forage notes 19(2):48-49.

Knowles, R.P. 1961. Annual report, Crops Section, Agriculture Canada, Saskatoon, SK.

Knowles, R.P. 1969. Producing certified seed of bromegrass in Western Canada. Canada Dept. of Agriculture. Publ. #866.

Koturbash, L. and Eagle, A. 1991. Dryland perennial forage establishment. Prairie Farm Rehabilitation Administration, Regina, SK.

Lawrence, T. 1957. Emergence of intermediate wheatgrass lines from five depths of seeding. Can. J. Plant Sci. 37:215-219.

Lawrence, T. 1962. Winter survival of intermediate wheatgrass following a period of prolonged drought, as influenced by fertilizer. Forage Notes 8(3):42-44.

Lawrence, T. 1963. The influence of fertilizer on the winter survival of intermediate wheatgrass following a long period of drought. J. Brit. Grass. Soc. 18:292-294.

Lawrence, T. 1981. Clarke intermediate wheatgrass. Can. J. Plant Sci. 61: 467-469.

Lawrence, T. 1982. Registration of Clarke intermediate wheatgrass. Crop Sci. 22:898.

Lawrence, T. 1983. Intermediate wheatgrass. Tech. Bull. 1983-2E. Agriculture Canada, Ottawa, Ont.

Lawrence, T., Ratzlaff, C.D. and Jefferson, P.G. 1991. Emergence of several Triticeae range grasses influenced by depth of seed placement. J. Range Mgt. 44:186-187.

Lawrence, T., Knowles, R.P., Childers, W.R., Clark, K.W., Smoliak, S., and Clarke, M.F. 1995. Forage grasses, pp. 275-315. In Slinkard, A.E. and Knott, D.R. (ed.), Harvest of gold: The history of field crop breeding in Canada. University Extension Press, Saskatoon, SK.

McElgunn, J.D. 1974. Germination response of forage grasses to constant and alternating temperatures. Can. J. Plant Sci. 54:265-270.

McKenzie, R.E., Heinrichs, D.H., and Anderson, L.J. 1946. Maximum depth of seeding eight cultivated grasses. Sci. Agr. 26:426-431.

Murrell, D. 1995. Grass seed production statistics of Western Canada. Sask. Agr. and Food.

Najda, H., Lopetinsky, K., Bjorge, M., and Witbeck, B. 1994. Harvesting grass seed. Agri-fax: Field crops. Agdex 127/50-1. Alta. Ag., Food and Rural Dev., Edmonton, AB.

Newfield Seeds Ltd. 1993. Effect of row spacing in seed production of meadow bromegrass, intermediate wheatgrass, and crested whestgrass. Agriculture Development Fund, Regina, SK.

Newfield Seeds Ltd. 1993. Residue management in forage seed production. Agriculture Development Fund, Regina, SK.

Patterson, J.K., Schwendiman, J.L., Law, A.G., and Wolfe, H.H. 1956. Producing grass seed in Washington. Wash. State Univ. Coop. Ext. Serv. Publ # 41, Pullman, WA.

Peterson, A.G. and Vea, E.V. 1971. Silvertop of bluegrass in Minnesota. J. Econ. Entomol. 64:247-252.

Saskatchewan Agriculture and Food. 1997. Crop protection guide: 1997. Saskatchewan Agriculture and Food, Regina, SK.

Schaber, B.D. 1994. Effect of spring burning of intermediate wheatgrass on some insect pest populations and yield. Forage notes 37:54-55.

Seaman, W.L. 1980. Ergot of grains and grasses. Ag. Can. Publ. #1438. Agriculture Canada, Ottawa, Ont.

Senter, W.R., Loveland, R.W., and McMurphy, W.E. 1975. Cool season grass seed germination as affected by storage time in fertilizer. J. Range Mgt. 28:331-332.

Smoliak, S. 1981. Hay and pasture crops: Kinds of forage crops, p. 7-37, In Alberta Forage Crops Advisory Committee, Alberta Forage Manual, Alberta Agriculture, Edmonton.

Soroka, J.J. 1991. Insect pests of legume and grass crops in Western Canada. Agr. Can Publ. #1435.

Stoner, K. and Horton, P.H. 1992. Increasing forage seed production with fertilizer - 1991 Extension. Agriculture Canada, Melfort, SK.

Tober, D.A. 1988. Methods and timing of grass seed harvest, pp. 4:1-9. In Johnson, J.R. and Beutler, M.K., Proceedings of Northern Plains Grass Seed Symposium, South Dakota State University Research and Extension Center, Rapid City, SD.

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