Seed Production of Slender Wheatgrass

I. Introduction

Slender wheatgrass, *Elymus trachycaulus* (Link) Gould ex Shinners or *Agropyron trachycaulum* (Link) Malte, is a native short-lived perennial bunchgrass. It was widely used for seeding in Western Canada and was known as western ryegrass during the early days of agriculture. Around 1920, slender wheatgrass along with smooth bromegrass and Grimm alfalfa represented the "forage triumvirate" for the prairies. With the introduction of crested wheatgrass during the 1930's, slender wheatgrass was replaced as a major forage because the newly introduced grass produced more "horsepower" per acre, had a longer productive life, was more drought resistant, and was less susceptible to disease and insects.

Annual production of slender wheatgrass ranged between 25 - 50 tonnes over the past six decades. During the mid 1970's, production rose to 150 tonnes annually for a few years, but then declined to traditional levels. Pedigreed production has increased to about 500 acres recently as native species are preferred for reseeding reclamation and conservation areas. The main varieties multiplied in Canada under pedigreed regulations have been Revenue, Adanac, and recently, AEC Highlander. Average seed yields of slender wheatgrass are 200 kg/ac, but yields as high as 300-400 kg/ac have been recorded.

II. Field selection

A. Adaptation

The grass is a leafy bunch grass with dense fibrous roots to a depth of about 45 cm. The bunches enlarge by tillering to a diameter of about 30 cm. The base of the stems has a reddish or purple color. The grass is adapted to a wide range of soils, but performs better on sandy loams. The grass is less tolerant of drought than crested or western wheatgrass. It requires more than 350 mm of annual precipitation, but is not tolerant of waterlogged soils. The grass is highly productive for the first few years after seeding before decreasing in a stand. It is less competitive with weeds than other wheatgrasses, but is tolerant of shade.

The grass has excellent germination and emergence and is well suited to low areas prone to salinity. Seed stalks are 60-120 cm tall with an abundance of leaves. The seeds are larger than crested wheatgrass. Seed yields are more consistent in regions receiving 350-500 mm of annual precipitation. Under dry conditions, seed head formation may be inadequate to justify harvest of the seed.

B. Freedom from weeds

The field selected for slender wheatgrass 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 disqualify the seed for market as pedigreed seed.

Weeds with similar size and shape of seeds to slender wheatgrass are extremely difficult to separate at the cleaning plant. Primary noxious weeds which are inseparable are quackgrass, Canada thistle, and perennial sow thistle. Secondary noxious weeds which are difficult to remove from seed lots include wild oats, stickseed (bluebur), and Persian darnel. Downy brome is a particularly difficult weed to control in seed stands of slender wheatgrass. Fields selected for seed production of slender wheatgrass 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 in the soil 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

Slender 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 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. Slender wheatgrass 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 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 slender wheatgrass 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 slender wheatgrass as required by CSGA regulations

Class of seed sown		Class of seed harvested	Contaminating crop	Number of interv
Breeder	Foundation	Non-pedigreed or different variety of slender wheatgrass		5 seasons
Breeder	Foundation	Same variety of slender wheatgrass		3 seasons
Breeder or Foundation		Certified	Slender wheatgrass	2 seasons

A field sown with Breeder slender wheatgrass seed is eligible for three years of Foundation plus two years of Certified seed production. A field sown with Foundation slender wheatgrass seed is eligible for five 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 will be 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.

Slender wheatgrass is one of the few self-pollinated grasses. The isolation requirement depends on the class of seed produced and the size of the field as summarized in Table 2.

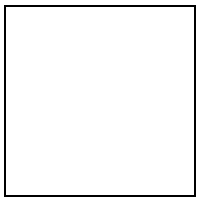
Table 2: Isolation distances required by CSGA regulations

	Pedigree of Seed Produced	
Field Size (ac)	Foundation	Certified
Less than 5 acres	400 m	150 m
More than 5 acres	300 m	50 m

III. Crop establishment

Much of the acreage of slender wheatgrass for seed production is sown with certified seed. Care is required to purchase stock seed which is free of downy brome contamination. Downy brome is a potentially serious weed which occasionally appears in seed from American sources. Downy brome has a reddish head colour and if nested in new stands of slender wheatgrass should be eliminated immediately. Marketability of slender wheatgrass seed free of downy brome is much greater and commands a premium in the marketplace.

The main objective for the establishment year is to produce a healthy stand of seedlings which are vigorously tillering. Slender wheatgrass may be sown with any conventional planting equipment if shallow seeding and adequate packing are achieved. Sowing no deeper than one 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 (Figure 1). Although air seeder cultivators and hoe drills have successfully established slender wheatgrass, 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 firm the soil prior to seeding. A rainfall following the final tillage operation will also firm and moisten the seedbed.

Simple equipment modifications relieve many potential difficulties and minimize the risk of poor establishment. A packing wheel 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 slender wheatgrass seed crop may be sown any time between early May and mid July with little difference in seed yield for the first seed harvest. With longer delays in seeding,

the first crop seed yield may be reduced, but subsequent crops often compensate for the smaller initial seed crop. Late fall and dormant seedings also work well for establishment of slender wheatgrass, but no seed will be produced until the second fall after seeding.

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

Slender wheatgrass flows much better than many of the chaffy grasses, but it will bridge in seed cups if the seed sample is chaffy. Bridging causes inconsistent plant stands and missing seed rows. Agitators in the seed box prevent bridging and improve 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 P205/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 slender wheatgrass 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. Because slender wheatgrass is a bunch grass, it should be sown with a row spacing of

12 to 18 inches. The seed yield of the first year or two of a stand must be maximized because of the short-lived nature of the grass. The wider row spacings are recommended for lighter textured soils.

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 or seed boots 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.

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. The seeder should be calibrated to sow 12 - 20 seeds per foot of seed row. When another material is mixed with the seed to eliminate bridging, the seeds per foot method of drill calibration eliminates guesswork. Using the seeds per foot method, the same rate of 20 seeds per foot of seed row is appropriate. Slender wheatgrass, on average, contains 159,000 seeds per pound. For a row spacing of 1 foot and a seeding rate of 20 seeds/ft, one acre (43,560 ft2) contains 43,560 feet of seed row and requires 871,200 seeds or 5.5 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 slender wheatgrass for seed production on fallow or partial fallow, nitrogen is 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 40-60 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 deficiency are 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 marginal once the stand is established. For fields testing less than 15 lb P/ac, phosphate fertilizer should be applied at 50-75 lb P205/ac. Likewise, for fields testing less than 200 lb K/ac, 100 lb K20/ac. should be applied prior to sowing the grass. Sulphur levels will be adequate if the field has been fertilized with enough sulphur for optimum canola production within the last two years. Slender wheatgrass responses to

micronutrients have not been documented on the prairies, but the extensive root system of perennial grasses is likely able to absorb all required micronutrients.

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 P205/ac is generally safe.

D. Companion crop

Seed production of slender wheatgrass is higher when sown without a companion crop. The seedlings grow larger, tiller more, and compete more effectively with weeds during establishment and first seed year when sown without a companion crop. Slender wheatgrass seedlings are able to recover from the reduced vigour associated with establishment under a companion crop better than many other grass seed crops. 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 are flax and oats.

IV. Crop Management

A. Weed control

Weed control options are limited once the slender wheatgrass 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 slender wheatgrass seedling, reducing its 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 a wild oat herbicide 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, fewer weeds will germinate 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 of quackgrass in slender wheatgrass is not available. Quackgrass can only be removed from the field after sowing by spot spraying glyphosate with a backpack sprayer or hand roguing. 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 slender wheatgrass seed. Secondary noxious weeds such as wild oats, Persian darnel, scentless chamomile, shepherd's purse, stickseed (bluebur), and stinkweed are tolerated in small numbers, i.e. 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 these weeds must be eradicated in the field.

The seed grower must be vigilant to prevent re-introduction of weeds to the field. 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 slender wheatgrass seed fields can lead to significant seed yield losses. The more common disease problems is head smut, and ergot. Head smut can be a major fungal disease in slender wheatgrass seed crops. Spores from inflected seed heads are dispersed to new seeds during harvesting. Smut is characterized by a seed head which has been totally destroyed by the fungus. The seeds are replace by a mass of black spores. The disease is best controlled by using smut-free seed and properly applying a systemic seed treatment registered for control of loose smut.

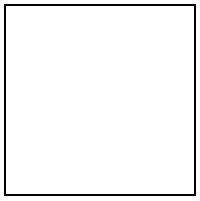
Ergot is indicated by collection of a sticky honeydew on the surface of infected florets during flowering or large black structures that replace individual seeds in the mature head. Ergot is controlled by sanitation and by use of ergot-free seed. Seed cleaning is able to remove most of the ergot bodies 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 also reduce the survival of ergot bodies. Sanitation of field edges or mowing will prevent infection from adjacent field edges.

Silvertop has been reported in slender wheatgrass. Silvertop reduces 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. Insect puncturing or feeding and local fungal infection above the topmost node are often associated with silvertop seed heads. The end

result is a conspicuous white seed head with no seed. The white seed head is easily removed from the stem by tugging on the white head

C. Irrigation management

Slender wheatgrass responds very strongly to good moisture conditions (Figure 2). Irrigation will increase seed yields if moisture stress occurs during the rapid spring growth, pollination or seed development stages. Frequent light sprinkler irrigation during establishment provide adequate moisture for germination and establishment. Flood irrigation is difficult in newly seeded fields because of the risk of erosion and crusting. Once the crop is established, irrigation during periods of high evapo--transpiration will promote vigourous growth. Soil moisture should be maintained above 50% of field capacity. Adequate soil moisture during the period of rapid growth in spring and during the boot stage are the most critical periods for high seed yields. Water penetration to a depth of 60 - 120 cm indicates adequate soil moisture. The soil profile should be at field capacity just prior to pollination. Irrigation during flowering may reduce seed set, but a final irrigation just after pollination may be required to fill the developing seeds. Seed production of slender wheatgrass on dryland is also feasible, but seed yields are more variable.



V. Harvest

Grasses need about 30 days after flowering for the seeds to develop. Hot, dry weather shortens the ripening period while cool, moist conditions delay seed maturity. Grasses grown under irrigation or moister conditions have a higher ash content which increases the likelihood of shattering. Ripening 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 important to determine the best time to harvest. Slender wheatgrass is usually ready to swath in mid August. The crop is ready to swath at the hard dough stage which corresponds to a seed head moisture content between 40-45%. At this stage of maturity, firm thumbnail pressure is needed to imprint the seed. The seed heads will be brown, but the stems will still be green. Some seed will shatter when the seed head is firmly struck against the palm of the hand.

The moisture content of the seed head is unreliable when determined with conventional grain moisture testers. The seed head should be clipped off just below the lowest seed. Sample enough seed heads to weigh about 100 g. After determining the wet weight, dry the sample in a conventional oven set at 82oC until the sample reaches a constant weight. The sample may also be dried in a microwave oven using relatively short heating intervals of about 1 minute. Place a

cup of water in the microwave with the sample to prevent it 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.

Conventional equipment is suitable for harvest of slender wheatgrass. Some combines may separate more seed if equipped with a modification kit to slow the fan speed. Swathing and picking up the windrow is usually the least risky harvest method, but in years of low seed yield, early maturity, or reduced foliage, straight combining may be more appropriate. Slender wheatgrass has a moderate shatter risk relative to other grasses and seldom lodges unless very heavy rates of nitrogen have been applied. Swathing early in the morning or in the evening or at night 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 within the swath.

Under good drying conditions, the crop will be ready to combine in 4-7 days after swathing. Because of the potential for contamination and the value of grass seed, thoroughly clean the combine before threshing grass seed. Initial combine settings recommended for slender wheatgrass are a cylinder speed of 1000 rpm and a concave clearance of 1/16". The fan speed is generally set between 400-500 rpm with the sliding covers over the exterior fan housing closed. The combine should be set so that the lemma and palea are retained on the seed. Seeds which retain these seed parts have longer viability in conventional storage. The concave setting should be adjusted to minimize straw breakage so the sieves do not become clogged. A properly adjusted concave just breaks up the head into separate seeds. Maintain an even flow of material into the combine. Slender wheatgrass 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. A very clean sample, however, usually indicates that too much seed is being lost. Use a shovel to check seed loss at the back of the combine. Watch for plugging of the return when the sample is quite chaffy. 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%.

Slender 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 hand, seed shatter is imminent and the field should be straight combined immediately. This is usually about 3-5 days after the crop was ready for swathing. The risk of losing the crop from brisk winds is high. Seed that is direct combined needs immediate aeration and drying to maintain seed quality. Some grass seed growers install an aeration tube directly into their grain truck so that the seed can be aerated without dumping into a storage bin. Running the seed over a sieve to remove much of

the green leaves, insects, chaff and short-stemmed straw reduces the risk of heating in the direct combined seed. Significant heating which reduces the viability of the seed may occur within only a few hours.

Slender wheatgrass seed is one of the easiest grasses to handle, but, depending on the chaff in the sample, can be challenging. The seed may flow more like silage than like grain, especially if the sample is not dry. Belt conveyors and front-end loaders handle chaffy grasses gently and efficiently. Large diameter augers can effectively transfer the seed if the intake opening is large enough to avoid bridging. In the grain bin, the seed is sometimes more easily handled with a pitchfork than with a shovel.

Drying of grass seeds must be carefully done 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 seed germination. 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 slender wheatgrass which are critical to sustaining seed yield potential are stubble management and nitrogen fertilization.

A. Stubble management

The first step is to windrow the straw behind the combine and bale and remove the straw as soon as possible after threshing. If the stubble was cut quite long and moisture conditions are good, the stubble should also be windrowed, baled, and removed as soon as possible to stimulate high future seed yields. When the fall is very dry, this stubble could be left until spring to trap moisture. Once spring arrives, the long stubble should be burned or clipped and removed before regrowth begins in spring. The weather will not cooperate in some years to allow burning in spring before regrowth occurs.

B. Nitrogen management

Nitrogen increases the seed yield of grasses primarily 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. Slender wheatgrass can develop new tillers during the fall if moisture is available. The response to nitrogen of slender wheatgrass has been negative in some experiments, especially if the field is naturally quite fertile and moisture is limiting (Figure 2). An early September nitrogen application of 20-25 lb N/ac under these conditions will promote greater tillering and increase the number of seed-forming tillers. In early October, the application of an additional 50-55 lb N/ac will stimulate the growth of the young developing seed heads in early spring. If conditions are

dry, all 70-80 lb N/ac can be applied in mid-September or early October. If the weather turns very cold and the nitrogen cannot be applied until spring, all 70 lb N/ac should be applied as soon as spring breaks, preferably prior to the greening of the grass. If spring arrives late or the fertilizer cannot be applied until May, the rate should be decreased to 30-40 lb N/ac. Established irrigated fields require a total application of 100-125 lb N/ac per year, but this rate needs to be reduced if lodging occurs.

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

Slender wheatgrass is taken out of rotation effectively by glyphosate application. The crop should be cut as high as possible during the last harvest season to leave as many green leaves as possible for absorption of glyphosate. Following harvest, glyphosate should be applied at 1-2 liter/ac on the green growth. 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 slender wheatgrass during the growing season.

VIII. Additional references

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