## The effects of grazing on cool-season forage crops grown for seed production in the Peace Region of British Columbia and Alberta - a review of published papers showing the effects of grazing on grass seed production.

Creeping red fescue (*Festuca rubra* L. var. *rubra*) is commonly grown for seed production in the Peace region of British Columbia and Alberta. The crop is traditionally seeded and harvested for two years before rejuvenation is needed to reduce the density of the stand to promote high seed yields. In the last 10 years the wild elk population has increased in the Peace region and are becoming a problem for fescue seed producers. Elk and other wildlife graze the newly rejuvenated creeping red fescue fields from the fall through to spring. It is unknown as to the extent of the damage caused by this grazing. This is a literature review of published papers from studies showing the affects of grazing on seed yields of cool-season grasses.

### Grass Seed Physiology

In cool-season perennial grasses, the plant tiller has a sequence of stages which it must go through in the production of seed. After germination or rejuvenation the grass plant produces a shoot that consists of leaves and roots. These shoots have a growing point which continues to produce leaves under favourable growing conditions (Elliott, 1978).

Literature suggests that the seed yield potential in cool-season grasses is based on the plant development processes that takes place before floral induction (autumn regrowth period) (Chastain & Young III, 1998). Many factors affect the induction process such as plant age, species, fertility, plant development and growing conditions as well as the clipping or grazing of the plant tillers (Yoder, 2000). The basal diameter of vegetative tillers in autumn is related to flowering and seed yield in young stands but not in older stands of creeping red fescue and kentucky bluegrass. Autumn tiller height is related to flowering and seed yield in creeping red fescue and kentucky bluegrass, regardless of the age of the stand. Green leaf number was a poor indicator of seed yield potential in many of the cool-season grasses, including creeping red fescue. As much as 92% of the potential seed yield is set before the onset of conditions favoring vernalization (Chastain & Young III, 1998).

In the fall or early winter the plant undergoes veneralization which is a chemical change in response to low temperatures (Elliott, 1978). This chemical change is called primary induction. In creeping red fescue, primary induction is completed in only those tillers that have had a full season of uninhibited growth.

The next stage of development is floral initiation which is the transformation of the vegetative growing point to the floral state. Only then can heading and seed development occur (Elliott, 1978). In creeping red fescue this stage occurs shortly after the spring thaw which is earlier than most other grasses (Yoder, 2000). Floral initiation begins with the development of a seedhead at the base of the tiller. As the stem develops and elongates the seedhead emerges and then anthesis (flowering) can occur.

Fairey et al conducted trials at Beaverlodge, Alberta to evaluate whether creeping red fescue seed yields could be optimized by manipulating the initial plant density and arrangement of plants (Fairey & Lefkovitch, 1996). Individual plants were transplanted at 7 densities and 3 row spacing in the field. Their findings showed that stands of creeping red fescue should be established to provide an initial density of 12-25 plants/$m^2$ in rows no wider than 20 cm to optimize seed yields for each of two consecutive crops. When only one harvest year is planned an initial density of 12-100 plants/$m^2$ on a 20 cm row spacing or 12-50 plants/ $m^2$ on a 40 cm row spacing is needed to optimize seed yield. When two consecutive harvests are planned, an initial density of 6-25 plants/$m^2$ on 20 cm row spacing or 6-50 plants/ $m^2$ on 40 cm row spacing is needed to optimize seed yield over the 2 years.

Fairey et al also studied the reproductive components and seed characteristics of creeping red fescue (Fairey & Lefkovitch, 1996). The natural growth habit of creeping red fescue involves a steady proliferation of tillers which eventually become too dense to form seedheads. The study showed that the seed yield per plant, the number of seedheads per plant and the number of seeds per plant decreased as the density increased. The seed yield was closely correlated with the number of seedheads per square meter which increased with density in the first year but decreased as density increased in years 2 and 3. They conclude that a relatively high density of well spaced plants is required at establishment to optimize seedhead formation in the first crop year but is detrimental to seedhead formation and seed yield in the following years.

Any clipping or grazing during the development process may adversely affect seed production. Clipping or grazing during this period when the growing points are elevated may remove the growing point or seedhead from the plant. This will produce an ineffective tiller which will not produce vegetation or seed. Time of grazing and intensity of grazing are of major concern in grass seed production.

**Review of published research**

There was no published research showing potential yield losses when creeping red fescue is grazed by elk during the dormancy of the grass or in the spring when the grass breaks dormancy and begins spring growth. There have been some trials involving the use of sheep or cattle grazing grasses used for seed production.

Pringle et al conducted a trial at Beaverlodge using cattle to graze creeping red fescue to determine the influence of grazing on subsequent plant development and seed yield (Pringle, Elliott, & Dobb, 1969). Yearling steers were used to graze a rejuvenated field of creeping red fescue. A control using 1) no grazing - seed harvested was used as a control to evaluate, 2) no grazing - aftermath cut as hay after seed harvest, 3) heavy grazing from seed harvest to freeze-up, 4) medium grazing from seed harvest to freeze-up and 5) spring grazing followed by fall grazing. Fall grazing occurred from early September until early October and the spring grazing took place early to mid May. They found that under fall grazing of moderate intensity, seed yields were reduced by 8%, under fall grazing of heavy intensity seed yields were reduced by 16% and when grazed in the spring and fall seed yields were reduced by 35%. The high reduction in seed yields from spring grazing was attributed to the removal of floral parts by the steers. The reduction in yield from fall grazing was attributed to the removal of fall growth which limited the root reserves and leaf area of the creeping red fescue when flowering was induced.

Nigel Fairey at Beaverlodge studied the effects of post-harvest management on creeping red fescue seed yield (Fairey N., 2006). Three methods of post-harvest management in late September to early October was used after the first harvest year in 1999: 1) flail mowing to 10 cm and residue removal in the fall after seed harvest; 2) disc mowing to 5 cm and residue removal in the fall after seed harvest and 3) short-duration, intensive grazing by sheep in the fall after seed harvest. These treatments were applied in late September to early October in 1999 and seed yields were determined in the 2000 seed harvest year. Based on one year of assessment Fairey found little difference in the mechanical harvest treatments but found nearly a 50% reduction in seed yield when grazed by sheep. The sheep grazed almost all of the green vegetation but not the stubble from the previously harvested crop. It was felt that the close grazing and the treading by the sheep's hooves removed or damaged the growing points in the crowns of the creeping red fescue. Less intensive grazing may have less of an effect on seed yields.

In 2004 in the Spirit River area of the Peace region of Alberta, Gary Ropchan and Melissa Fuchs with the Central Peace Conservation Society(CPCS) conducted a grazing trial on a creeping red fescue field for seed production. The treatments consisted of a check with no grazing, mowing on November 4$^{th}$ and grazing by cows for 5 days beginning on December 19$^{th}$. The 2005 seed harvest indicated no seed yield difference between the check and the mowed strips but there was a significant seed yield loss of 3.5% on the grazed strips. (Yoder C. , 2010)

Research in Great Britain, under different growing conditions than the Peace Region, showed yield losses when grazed at specific times of the year (Green & Evans, 1956). Green et al assessed the effect of cattle grazing five grasses – cocksfoot (orchardgrass), meadow fescue, tall fescue, creeping red fescue and perennial ryegrass. The treatments used were: 1) control – no grazing; 2) grazed October; 3) grazed October and December; 4) grazed December; 5) grazed December and February; 6) grazed December, February and March; 7) grazed December, February, March and April. The daily mean temperatures in Berkshire England would be >0°C during these grazing periods which would allow the plants to maintain some growth and development. October grazing during the seeding year reduced cocksfoot yields by 24%, red fescue yields by 18%, tall fescue by 7% and the meadow fescue and ryegrass were unaffected. In the second year after seeding, cocksfoot showed some yield loss with an October grazing but the other grasses were unaffected. An October grazing followed by a December grazing affected the cocksfoot throughout the trial but only had an effect on the other grasses in the initial seeding year with little seed loss over the three years of the trial. The December grazing only treatment had no significant effect on the seed yields of any of the grasses. When grazed in December and again in February, red fescue had a 29% seed yield loss in year one but over the 3 years of the trial had a 10% loss. The other grasses had little or no seed yield losses over the trial period. When grazed 3 times in treatment 6, the red fescue was affected throughout the trial period with seed yield losses of 26% while cocksfoot and tall fescue showed small losses. When grazed 4 times from December to April, all the species had very significant seed yield losses. Tall fescue and red fescue were the most seriously affected with losses in the first year of 82% and 80% respectively and over the 3 year trial period had losses of 42% and 52% respectively.

Winter grazing in areas where cool-season grasses can maintain some growth would be much different than in areas where complete dormancy occurs. Green et al showed that in most species the initial seeding year responded to grazing differently than the subsequent years. Removal of some of the top growth in years 2 and 3 may have a rejuvenational affect on some of the species as there was little or no yield loss and in many cases there was a yield increase. Early flowering species such as red fescue suffered the most when subjected to an April grazing as the authors found a reduced number of fertile tillers following the late grazing (Green & Evans, 1956).

In Oregon, annual ryegrass was grazed by sheep to determine seed yield response to spring grazing during early stem elongation (Young III, Chilcote, & Youngberg, 1996). Young et al studied 4 durations of spring grazing (late February – early April) of annual ryegrass using sheep. Grazing was begun before the onset of stem elongation. Treatments were no grazing (G0), grazing until one-third (G1), two-thirds (G2) or all (G3) primary tillers had their apical meristems removed. The trial period was 2 years and the annual ryegrass was seeded in mid-September each year. In year one the minimum temperature over the trial period was 3°C and the maximum was 22°C, in the second year the temperatures were -4°C and 21°C respectively. Grazing did not affect the number of spikelets per spike or florets per spikelet in the first year but in the second year G2 and G3 reduced spikelets per spike. G2 and G3 affected seed weight in year 1 but not in year 2. The grazing treatments did not affect total herbage dry matter at seed maturity, seed yield or seed quality in either year. Young et al concluded that grazing annual ryegrass in late winter and early spring up to the time when the apical meristem of all primary tillers are removed (G3) does not reduce seed yields.

Kentucky bluegrass for seed production in Washington was clipped to simulate grazing in the fall and in the spring (Evans, 1975). Bluegrass was clipped in late September, early December, early March, late March and early April with various combinations of early and late grazings. Clipping was found to either increase or had no effect on seed yields, panicle numbers or seed weight. Clipping at the onset of panicle development in the spring slightly increased panicle numbers.

Clark et al studied the effects of winter grazing by geese on yields of annual and perennial ryegrass seed production in the Wilamette Valley, Oregon (Clark & Jarvis, 1978). Exclosures were used to compare grazed and ungrazed plots by Canada geese from October 1974 to July 1975. Sheep were used to graze 2 fields as part of this study. The ryegrass was grazed from late October until late April. Although the findings were variable the authors concluded that grazing by geese did not reduce seed yields and in some cases it may increase yields. Grazing by sheep however may occasionally reduce yield.

**Discussion**

The majority of the literature published on the effects of grazing on seed yields is from the north western United States, Great Britain and the Peace region of Alberta. None of the trials involved the use of elk in their grazing trials but there were some involving sheep and cattle. Sheep are thought to graze more similar to elk.

The research conducted by Pringle et al and Fairey at Beaverlodge in the Peace Region of Alberta, was the only research carried out using cool-season grasses that went into complete dormancy in the fall and resumed growth in the spring. Green et al in Great Britain, Young et al and Clark et al in Oregon used cool-season grasses which continued to be productive during the winter months rather than enter into dormancy. Evans in Washington used cool-season grasses that had a short dormancy period with little or no production in the winter months.

Pringle et al found an 8 – 35% seed yield loss when the creeping red fescue was grazed by cattle. When grazed in the fall and the spring, seed yields were affected the greatest with a 35% yield loss. Fairey realized a 50% seed yield loss with creeping red fescue when grazed heavily by sheep in the fall after the seed was harvested. Ropchan et al found that cattle grazing on creeping red fescue can reduce seed yields by 3.5%. Green et al grazed cattle during the seedling year and had seed yield losses of 24% in cocksfoot, 18% in red fescue and 7% in tall fescue but in subsequent years found only minor losses in cocksfoot. Red fescue had consistent losses when grazed in the fall and the winter. When grazed in December, February and March, red fescue had seed losses of 26% and when again in April the losses soared to 80% in the first year and were 52% over the three years of the trial. Young et al in Oregon determined that there was no seed yield loss in annual ryegrass when grazed in the fall at varying intensities. Evans in Washington found that Kentucky bluegrass seed yields increased slightly or remained the same when clipped to simulate grazing throughout the fall, winter and spring. Clark et al in Oregon concluded that geese grazing annual and perennial ryegrass had no effect on yields but when grazed with sheep, there were occasional yield losses.

Fairey et al showed that plant density had a major influence on creeping red fescue seed yields and densities of 6-25 plants/$m^2$ on a 20 cm row spacing or 6-50 plants/$m^2$ on 40 cm row spacing is needed to optimize seed yield over the 2 years of seed production. Elk grazing and elk disturbance may affect plant populations sufficiently to increase or decrease seed yields in a creeping red fescue field.

**Conclusion**

The published research concludes that there can be seed yield losses in creeping red fescue fields when grazed during the fall, winter and/or spring by cattle or sheep. Similar results can be expected when elk graze during these periods as well. Grazing intensity, time of grazing, forage dormancy, forage species and the age of the forage will all affect the amount of seed yield losses in grasses grown for seed production.

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