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Crested wheatgrass



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Crested wheatgrass

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SUMMARY

Crested wheatgrass was introduced to Western Canada from Eastern Europe about 1900. It is particularly well adapted to the Dark Brown and Brown soil zones of Saskatchewan, southern Alberta, and the intermountain areas of British Columbia. It was widely used in the 1930s for reseeding badly eroded areas, and since then for hay production and for pasture and rangeland alone or with alfalfa. It outyields native grasses severalfold and is particularly useful in complementing native pastures, because it produces most of its growth in May and June before the native pasture is ready for grazing.

RÉSUMÉ

Originaire de l'Europe de l'est, l'agropyre à crête a fait son apparition dans l'ouest du Canada vers les années 1900. Il convient particulièrement bien aux zones de sol brun foncé et brun de la Saskatchewan et du sud de l'Alberta, ainsi qu'aux terres qui s'étendent entre les montagnes de la Colombie-Britannique. Dans les années 1930, l'agropyre à crête était communément utilisé pour lutter contre l'érosion et de nos jours, on le sème en champ pour son foin et en pâturage ou en grand parcours, seule ou en association avec la luzerne. Son rendement est de loin supérieur à celui des graminées indigènes pour lesquelles il est un complément utile, car sa croissance est maximale en mai et en juin, lorsque les plantes locales ne sont pas encore prêtes à être broutées.

INTRODUCTION

Crested wheatgrass is a major cultivated grass in Western Canada. It was introduced from Eastern Europe to North America about 1900, but was not widely distributed in Western Canada until 1930. In the subsequent drought period 1931-37, it was used extensively to reseed soil-drifted areas and abandoned farmland. The grass has gained general acceptance as an excellent spring and fall pasture crop for dry areas. It is also used for dryland turf and roadside seedings in the dry prairie and intermountain areas. Seed production in Canada averaged 473 000 kg for the years 1975-79, with approximately 60% of this seed exported to the United States.

ADAPTATION

Crested wheatgrass is particularly well adapted to the Brown and Dark Brown soil zones of Saskatchewan, southern Alberta, and the intermountain areas of British Columbia. Yields of crested wheatgrass are comparable to those of other grasses in the Black soil zone, but stands do not persist well in this zone. It is suited to most soils, including sands and clays. Crested wheatgrass is not tolerant of flooding, and if submerged for 7-10 days the subsequent yields are seriously reduced. Present strains are not well adapted to saline soils. Other grasses such as Russian wild ryegrass, Altai wild ryegrass, tall wheatgrass, and slender wheatgrass show more salinity tolerance. Stands of crested wheatgrass usually remain productive for many years. In the Brown and Dark Brown soil zones many stands have been maintained for 30-40 years.

DESCRIPTION AND VARIETIES

Crested wheatgrass is a bunch-type plant. Single plants in thin seedings may form large tufts 30-45 cm across. There is considerable variation in height and form of plants for different cultivars of crested wheatgrass (Fig. 1 and Table 1). The Fairway type, Agropyron cristatum (L.) Gaertn., is shorter and more leafy than the standard type, A. desertorum (Fisch.) Schult. Parkway is a taller form of the Fairway type. Summit and Nordan represent the standard type and are similar in appearance, although in the year of seeding Summit remains rosetted, whereas Nordan may head out. Leaves of the Fairway type characteristically have fine hairs or pubescence on the upper surface, whereas the leaves of the standard type are smooth. Nordan and Summit remain greener than Fairway and Parkway under severe drought. However, Fairway and Parkway stands last longer than those of Summit and Nordan under more moist conditions in the Black soil zone.



Fig. 1. Single plants of three crested wheatgrass varieties.
(Left): Fairway; (center): Parkway; (right): Summit.

Table 1. Comparison of crested wheatgrass varieties

Feature	Fairway type (<i>Agropyron cristatum</i>)		Standard type (<i>Agropyron desertorum</i>)	
	Fairway	Parkway	Summit	Nordan
Head shape	Short, wide	Short, wide	Long, narrow	Long, narrow
Leaf hairs	Upper side	Upper side	Nil	Nil
Plant height	60 cm	70 cm	71 cm	71 cm
Number of seeds per kilogram	480 000	480 000	360 000	360 000
Tip awns on seeds	Present	Present	Variable	Usually absent
Heading, year of seeding	Yes	Yes	Nil	Yes

One of the best ways of distinguishing the two types is by head shape (Fig. 2). Fairway and Parkway have shorter, wider heads than Summit and Nordan. Spikelets on heads in Fairway and Parkway are set at a wider angle to the rachis. Fairway and Parkway have 14 chromosomes; Summit and Nordan have 28 chromosomes. The two types do not cross readily, although some experimental hybrids have been produced.

Crested wheatgrass has an extensive root system, reaching a depth of nearly 3 m in old stands, resulting in large amounts of fiber being added to the soil. At Saskatoon, a 2-year-old stand produced 4 t of fiber in a hectare of soil to a depth of 30 cm, and about 8 t in an 8-year-old stand.

The Fairway cultivar was released in Canada in 1932 and is still popular. It is widely grown for pasture, roadside seedings, and dryland turf. Parkway was selected out of Fairway as a taller type, better for hay, and released in 1969. Summit was released in 1953, and Summit 62, a reselection with somewhat better seed yields, was released in 1962. Summit is the highest-yielding crested wheatgrass in Canadian hay trials, but has lost favor because of seed-cleaning difficulties. Approximately 50% of the florets in Summit are sterile, and these sterile florets may remain attached to normal seeds during cleaning. Nordan was released in 1958 in North Dakota, USA, and is now widely grown for forage and seed in Canada. The total Canadian pedigreed seed area for crested wheatgrass in 1980 was 1335 ha, with the following cultivar distribution: Nordan 45%, Fairway 42%, Parkway 12%, Summit 1%. Yields of forage and seed for these cultivars in Western Canada tests are given in Table 2.



Fig. 2. Heads of crested wheatgrass varieties:
A: Fairway or Parkway; B: Summit. (Nordan is similar to Summit but usually lacks tip awns.)

Table 2. Relative yields of crested wheatgrass varieties in Western Canada from experimental tests at Agriculture Canada research stations 1976-79

Variety	Hay	Seed
Fairway	100	100
Parkway	104	124
Summit	110	98
Nordan	102	102

Time of seeding and land preparation

In the prairie area, sow either in early spring or in late October just before freeze-up. Seedings in July and August increase the risk of loss from drought and heat damage, although in northern areas, summer seedings are often satisfactory. In the intermountain areas of British Columbia, seeding between late August and mid-October is preferred. Seeding in these areas between early April and mid-May also gives adequate stands, but higher seeding rates are required.

Seeding may be done directly into cereal stubble immediately after the spring breakup. Prior land preparation to control weeds is generally required when seeding late in the spring. If a companion crop is used, sow on fallow rather than on stubble land, because this reduces competition for moisture. Always pack freshly worked land to prevent it from drying out before seeding. Packing also helps to control depth of seeding. There is a real danger of getting poor stands if the soil is loose. Fall seeding into stubble prevents loss from soil drifting.

Depth of seeding

Deep seeding is the most common cause of stand failure with crested wheatgrass. Seed should be sown 1-2 cm deep. This is particularly important on heavy soils. Tests on loam soils under favorable conditions in the greenhouse show only 25% emergence of the Fairway type when seeded 5 cm deep, and 50% emergence of the standard type.

Alfalfa mixtures, rates of seeding, row spacings

For maximum production, crested wheatgrass should be grown with alfalfa. Grass-alfalfa mixtures yield up to two times as much as grasses seeded alone. Old stands of grass-alfalfa may yield four times as much as grass seeded alone. Competition from crested wheatgrass may eliminate

alfalfa in dry areas after a few years. Summit and Nordan, and to some extent Parkway, are less competitive than Fairway and allow a higher proportion of alfalfa in a mixture with higher yields (Tables 3 and 4).

Table 3. Hay yields of crested wheatgrass varieties in alfalfa mixtures, Saskatoon (30-cm row spacing, no fertilizer applied)

Variety	Hay yields (t/ha)			Average	Percentage of alfalfa Average of three tests
	Test 1 1968-70	Test 2 1969-71	Test 3 1974-77		
Fairway	4.37	4.24	4.84	4.48	26
Parkway	4.68	4.57	5.29	4.84	31
Summit	4.55	4.53	5.29	4.80	47
Nordan	4.55	4.71	5.18	4.82	49

Table 4. Hay yields of crested wheatgrass varieties in alfalfa mixtures, Swift Current (30-cm row spacing, no fertilizer applied)

Variety	Hay yields (t/ha)			Average
	Test 1 1967-75	Test 2 1969-77	Test 3 1971-79	
Fairway	1.69	1.84	1.72	1.75
Summit	1.98	1.99	1.96	1.98

Experiments in the Brown and Dark Brown soil zones show that the yield of hay, pasture, or seed from rows spaced 60-90 cm apart is as much as or more than the yield from rows spaced 15-30 cm apart (Table 5). Wide rows allow plants to escape from drought and encourage development of more alfalfa in the mixture. Disadvantages of wide spacing are lower yields for the first year after seeding, more difficult weed control initially, and an uneven surface for harvesting hay or seed. Cross seeding of the grass to the alfalfa is recommended for pasture in order to reduce competition on the alfalfa from crested wheatgrass.

Recommended seeding rates for alfalfa mixtures are given in Table 6.

Table 5. Forage and seed yields of crested wheatgrass at various row spacings

Location and soil zone	Row spacing (cm)	Hay t/ha	Seed kg/ha
Swift Current - Brown	15	0.85	-
	30	1.34	-
	45	1.41	127
	60	1.52	-
	75	1.72	-
	90	1.72	221
Saskatoon - Dark Brown	15	1.88	177
	30	1.95	177
	60	2.17	238
	90	2.08	268
Scott - Dark Brown	15	1.39	-
	30	1.39	-
	60	1.41	-
	90	1.97	-
Lethbridge - Dark Brown	15	3.07	132
	30	3.50	247
	60	4.26	345
Melfort - Black	15	2.94	-
	30	4.06	656
	90	3.83	821
Beaverlodge - Gray Wooded	15	-	212
	30	-	287
	45	-	340
	75	-	372

Table 6. Seeding rates for crested wheatgrass-alfalfa mixtures in various soil zones*

Soil zone	Main use	Row arrangement	Row spacing (cm)	Seeding rate (kg/ha)
Brown	Hay	Alternate rows	45-60	3 + 1
	Pasture	Cross-seeded rows	90	3 + 1
Dark Brown	Hay	Alternate or same rows	30-45	5 + 2
	Pasture	Cross-seeded rows	60	5 + 1
Black and Gray Wooded	Hay	Same rows	30	7 + 3
	Pasture	Crested wheatgrass seeded alone	30	7

*From Saskatchewan Guide to Farm Practice, 1981.

A handy method of checking seeding rates is to run the drill over a hard surface and count the number of seeds falling per metre of run. About 50-70 seeds per metre of run usually give a good stand.

CONTROL OF WEEDS

Old plants of crested wheatgrass compete well with weeds, but young stands are sensitive to competition from weeds or a companion crop. This competition may cause low yields of either hay or seed the year following seeding. Competition from the companion crop is less severe when the seeding rate of the grain crop is reduced to one-half the normal seeding rate, and when the cereal is cut early for hay or silage.

Crested wheatgrass should be 7-10 cm high before it is treated with herbicides. Pasturing young stands is undesirable because cattle tend to graze the grass and leave the weeds. To control weeds, mowing or swathing is preferable to grazing. Old weedy stands being harvested for seed should be treated with herbicides before the end of May. For perennial weeds, apply herbicides after the seed crop has been taken off.

USE FOR HAY

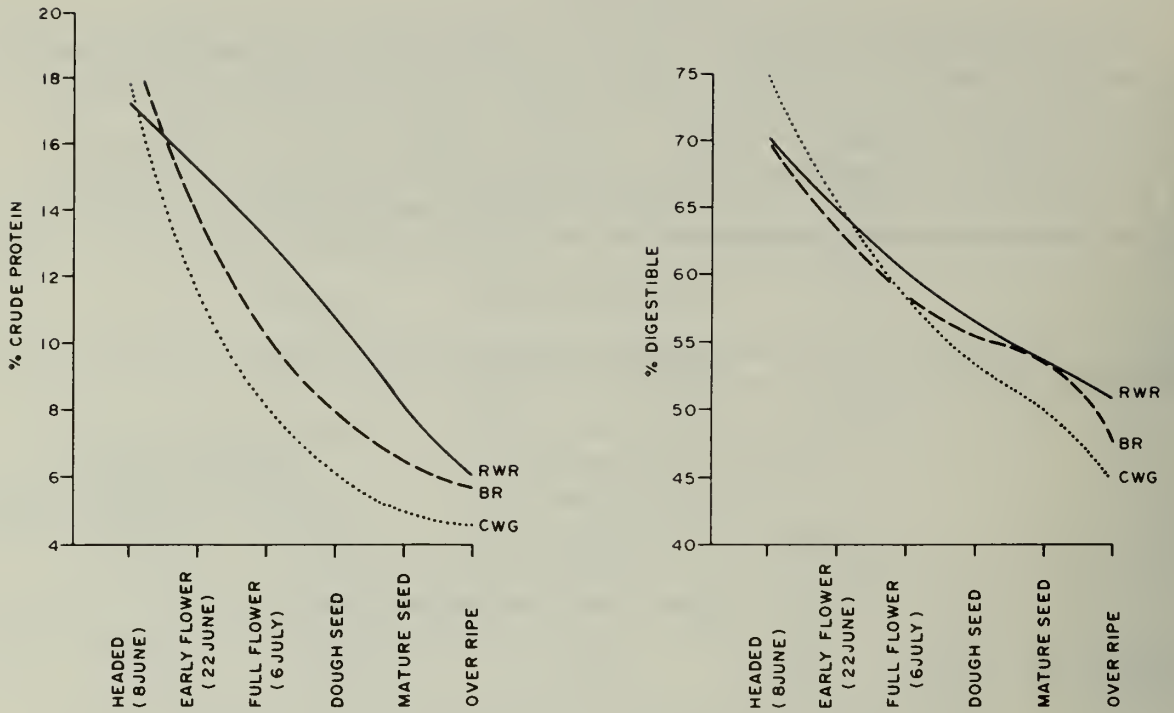
Crested wheatgrass compares well with other grasses in hay yield and hay quality (Fig. 3 and Table 7). The quality of hay, however, declines rapidly after heading. At Saskatoon, heading occurs about 10 June, and flowering occurs about 1 July. To obtain maximum yield of digestible nutrients, it is recommended that crested wheatgrass hay be cut during the second or third week of June, i.e., between heading and flowering. Crested wheatgrass-alfalfa mixtures may be harvested until 1 July without great loss of hay quality.

Table 7. Dry matter yields and protein content percentages of crested wheatgrass compared with other grasses

Grass	Yield of dry matter t/ha		Protein content percentage	
	Hay	Pasture	Hay	Pasture
Swift Current - single test harvested 1952-56				
Crested wheatgrass	2.3	1.4	7.4	11.4
Russian wild ryegrass	1.2	1.0	9.4	13.8
Saskatoon - three tests 1952-61, each test harvested for 4 years				
Crested wheatgrass	3.0	1.8	10.3	15.8
Russian wild ryegrass	3.0	2.5	10.2	17.6
Intermediate wheatgrass	3.5	2.1	9.1	14.9
Bromegrass	2.4	1.8	11.5	16.6
Melfort - three tests 1949-56, each test harvested for 4 years				
Crested wheatgrass	3.0	1.9	14.6	16.3
Russian wild ryegrass	2.0	1.8	14.7	18.4
Intermediate wheatgrass	3.9	2.3	13.8	14.2
Bromegrass	3.7	2.2	15.7	16.4

USE FOR PASTURE

Crested wheatgrass is used extensively for pasture in the drier parts of Saskatchewan, Alberta, and British Columbia. It is unexcelled for early spring pasture. Russian wild ryegrass is also early, but it does not provide the volume of production of crested wheatgrass. Crested wheatgrass makes most of its seasonal growth and production in the first 5 or 6 weeks through May and early June. For maximum utilization, grazing should be heavy during this early spring period.



Protein content of crested wheatgrass (CWG), Russian wild ryegrass (RWR), and smooth bromegrass (BR).

Digestibility of crested wheatgrass (CWG), Russian wild ryegrass (RWR), and smooth bromegrass (BR).

Fig. 3. Seasonal decline in digestibility and protein of crested wheatgrass hay compared with other grasses.

Crested wheatgrass is an excellent grass to complement native grass pasture or rangeland. It produces an abundance of high-quality grass before native grasses are ready for grazing. Because of the heavy milk flow of cows grazing crested wheatgrass through this May and early June period, calves on cows have shown exceptional growth rates. In turn, the native grass benefits greatly from deferred grazing.

In average seasons at Swift Current, about 0.4 ha of crested wheatgrass provides 4-6 weeks of good spring grazing for each cow and calf. At this location even better production is obtained by cross seeding crested wheatgrass to the alfalfa with both the grass and alfalfa seeded in rows spaced 90 cm apart. Bloat did not occur at Swift Current provided spring grazing commenced when the grass was 10 cm high and alfalfa growth had just started.

Crested wheatgrass often shows poor palatability compared to other seeded grasses or native grass. This, however, does not mean it is necessarily inferior. What it means is that optimum or maximum usefulness of crested wheatgrass requires controlled grazing management by fencing. If cattle are confined on crested wheatgrass, they will readily accept it as pasture and, in turn, do very well. However, if they are given a choice, they will neglect crested wheatgrass and overgraze either Russian wild ryegrass or native grass.

Taint in milk is likely to occur when crested wheatgrass is used for early spring grazing. This tainting is not a problem with beef cattle where calves only are using the milk. However, with dairy herds it is probably best to use Russian wild ryegrass for early spring pasture.

Concern has sometimes been expressed about the occurrence of scattered "stag" plants of crested wheatgrass that are not grazed. Actually this is more of a blessing than a curse. Scattered ungrazed plants of crested wheatgrass assist in holding drifting snow and result in a desirable snowpack for soil moisture buildup.

RESPONSE TO FERTILIZERS

Nitrogen fertilizer used on stands of crested wheatgrass that are 3 years old, or more, will give large yield increases. This is because crested wheatgrass grown alone has a high demand on soil nitrogen. After only a few years the nitrogen supply in the soil is used up. Without nitrogen the plants' growth is limited and they become pale green. This is sometimes referred to as a sod-bound condition. This condition is not a physical crowding of roots, as the name implies, but simply a symptom of an acute lack of nitrogen.

It has been shown that even in the drier areas, such as at Swift Current, crested wheatgrass can take up as much nitrogen as 50-70 kg/ha

per year under average to good precipitation. A kilogram of nitrogen can, under average to good soil moisture conditions, give an additional 20 kg of dry matter grass production, although the average may not be that high in the Brown soil zone.

For hay or pasture production the preferred time to apply nitrogen fertilizer is in early spring. An application can also be made in late fall, but some gaseous loss may occur then if urea or urea-containing granular or liquid fertilizers are used.

Fertilizer nitrogen on nitrogen-deficient stands of crested wheatgrass should be applied at about 50 kg/ha. If it is a dry year, and consequently not all used, it will remain in the soil for use in the next growing season. This is called "residual response" in succeeding years. It has been demonstrated that high rates of nitrogen, such as 200-300 kg/ha, or more, will give residual responses for 4-6 years. There is little response by grass to phosphorus fertilizers unless high rates of nitrogen are used on an annual basis. Additionally, a nitrogen-fertilized field of crested wheatgrass will commence growth slightly earlier in the spring than would a nonfertilized field. More importantly, it will show an accelerated rate of growth, thus producing earlier pasture use.

In an experiment at Swift Current where liveweight seasonal cattle gain was only 17-20 kg/ha on native rangeland, it was 70-80 kg/ha on unfertilized crested wheatgrass and 110-120 kg/ha when nitrogen was applied at the rate of 50 kg/ha. On grass intended for hay where 1 kg of nitrogen costs seventy cents per kilogram and gives 20 kg extra dry matter production, then an extra tonne of feed is obtained for an expenditure of \$35.00 for fertilizer.

SEED PRODUCTION

Crested wheatgrass is a good seed producer; yields up to 1000 kg/ha have been recorded. Seed yields depend greatly on moisture conditions, row spacing, age of stand, and fertilizer application (see Fig. 4, Table 8).

Rows spaced 60-90 cm apart give more seed than rows spaced 15-30 cm apart if stands are left down 3-4 years. Irrigation improves seed yields, particularly if fertilizer is also applied. Yields usually decline after the second seed crop, but fertilizers help keep yields up. Seed yields are often low for the first seed crop if a companion crop was used when the grass was seeded.

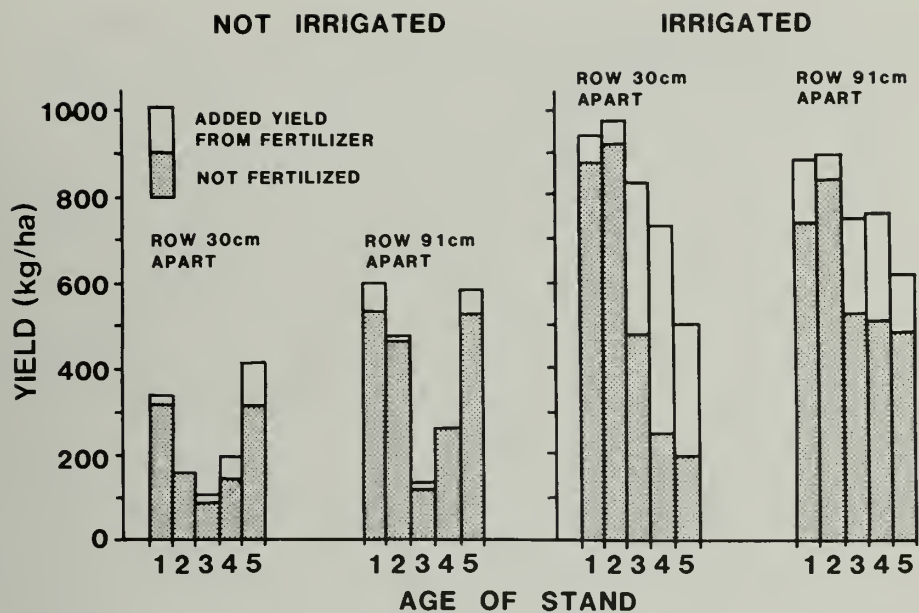


Fig. 4. Seed yields of Summit crested wheatgrass, Scott, Sask., at narrow- and wide-row spacing, and with and without irrigation and fertilization. Fertilizer nitrogen -- 50 kg/ha per year. Irrigation -- 38 cm by sprinkler.

Table 8. Effect of fertilizer on seed yields of Summit crested wheatgrass at Indian Head, Sask. (Nitrogen applied at the rate of 70 kg/ha each fall)

Treatment	1958	1959	1960	1961	1962	1963	1964	1965	Average
30-cm spacing									
Fertilized	169	204	473	4	262	264	52	154	198
Not fertilized	148	124	161	4	129	46	22	44	85
Three-row group*									
Fertilized	139	184	427	9	261	333	53	244	206
Not fertilized	150	166	244	9	153	89	26	163	125

*90-cm space between each three-row group, rows 30 cm apart in the group.

When seeding crested wheatgrass in rows spaced 90 cm apart, use a seeding rate of 2-3 kg/ha. Herbicides should be used to control weeds during the year of seeding. In subsequent years, inter-row cultivation should be done in the spring and early fall to kill weeds and volunteer crested wheatgrass. Inter-row cultivation tends to build up the rows above the general field level and this makes it difficult to pick up combine swaths. A combination of narrow- and wide-spaced rows will provide a strip to lay the swath on and give some yield advantage from wide spacings (see Fig. 5). This may consist of three-row groups spaced 30 cm apart, with 90 cm cultivated strips between these groups. Various combinations of rows can be made for various sizes of swathers.

An alternative method for short-term production is the use of 30-cm spaced rows with fairly heavy annual applications of nitrogenous fertilizers.

Swathing is preferable to straight combining because the crop shatters easily. Shattering also may occur when picking up the swath. Fairway and Parkway shatter more than either Summit or Nordan. Crested wheatgrass is usually ready for swathing in late July or the first week in August. Heads will be brown and stems still green at this time. The crop is ready for swathing when heads shatter a few seeds if struck across the palm of one's hand.

When threshing crested wheatgrass do not feed the machine too heavily. Concaves should be set to give a minimum of straw breakage to prevent clogging decks and sieves. Reduced cylinder speed with normal forward speed will reduce straw breakage. Concave clearance should be just enough to break up the heads into separate seeds. If spikelets are not broken up, they will be lost in later cleaning. The air blast and adjustable sieve should be checked carefully.



Fig. 5. Crested wheatgrass sown in three-row groups, showing the swath from three groups laid on one group.

Satisfactory cleaning can be done on the farm with the ordinary fanning mill. As a guide, the size of the opening in the top sieve should range from 1.2 to 2 mm wide and from 6 to 12 mm long. For the bottom sieve, round-hole openings 1-1.5 mm in diameter are suggested.

For maximum returns, seed growers should grow Certified seed of named cultivars rather than unnamed common seed. To grow Certified seed it is necessary to become a member of the Canadian Seed Growers' Association and follow its regulations. The Association handbook, Circular 6, states the classes of seed to sow in order to grow Certified seed and gives the isolation distances required. To produce Certified seed of most cultivars of crested wheatgrass, it is necessary to plant Foundation seed. For Nordan, Foundation or Registered seed can be used to produce Certified seed. Certified seed fields must be isolated from all other crested wheatgrass fields and volunteer plants by 50 m. For further details on Certified seed production write to the Canadian Seed Growers' Association, Box 8455, Ottawa, Ontario, K1G 3T1.

Seed yields can be maintained at a higher level by broadcasting nitrogen fertilizers (see Fig. 4 and Table 8). There is little response to phosphorus fertilizers such as ammonium phosphate 11-48-0. Nitrogen at the rate of 30-70 kg/ha is recommended for seed production on Brown or Dark Brown soils. This may be increased to 30-90 kg/ha on Black, Dark Gray, and Gray Wooded soils, and 40-130 kg/ha for irrigation. Under favorable conditions 2-3 kg of additional seed are produced for every kilogram of nitrogen applied.

RENOVATION OF OLD STANDS

Crested wheatgrass not growing with alfalfa and not fertilized usually shows a marked decline in yields after three hay crops (see Table 9). Seed yields usually decline more rapidly than hay yields, particularly with narrow-row spacings or if there is volunteer growth from shattered seed.

Crested wheatgrass sod will not recover from plowing as will brome grass sod. Experiments at Swift Current, Sask., and Mandan, ND, showed that attempted rejuvenation of old crested wheatgrass stands, with heavy duty cultivators, discers, and Noble blade gave unsatisfactory yield responses. In addition, this tillage left the field rough and difficult to mow. Best results by far were obtained by leaving the sod intact, and applying nitrogen fertilizers. Attempts to incorporate alfalfa in newly cultivated crested wheatgrass sod gave poor alfalfa establishment, and yields were below those when nitrogen fertilizers were used.

Herbicides applied in mid-June in combination with fertilizers improved yields more than the use of fertilizers alone. High rates of 2,4-D (acid equivalent 2.8-3.1 kg/ha) low volatile ester were used.

Table 9. Hay yields of Fairway crested wheatgrass for various ages of stands, tonnes per hectare (no fertilizer applied)

Age of stand	Test 1	Test 2	Test 3	Test 4	
Years	1940-55	1936-43	1937-43	1975-81	Average
1	2.0	2.2	1.8	4.9	2.7
2	2.7	1.1	3.8	5.0	3.2
3	3.6	3.6	4.9	2.8	3.7
4	2.0	3.1	1.1	1.9	2.0
5	2.5	1.1	1.6	1.6	1.7
6	0.9	1.6	2.2	0.9	1.4
7	0.4	1.8	1.3	1.0	1.1
8	0.4	1.1	-	-	-
9-16 average	0.7	-	-	-	-

REGRASSING ABANDONED FARMLAND AND DEPLETED RANGE

Crested wheatgrass is useful for regrassing farmland and overgrazed prairie of the Brown and Dark Brown soil zones. Russian wild ryegrass is also adapted for this purpose but establishment is slower than for crested wheatgrass, especially on sands.

If the land has not been out of cultivation long and only annual weeds are present, it is not necessary to prepare a seedbed. Seed the grass into dead weeds either in the fall or in early spring because this will protect seedlings from soil drifting. If perennial weeds are present or the soil is hard or badly cracked, some cultivation is desirable. Another good practice, wherever perennial weeds are present, is to work the land and seed a cereal crop for one season. Crested wheatgrass is then either fall seeded or spring seeded into the stubble. This practice is recommended where soil drifting is not likely to interfere with the establishment of the cereal crop.

Where native range is overgrazed and weedy, production can be improved by seeding to crested wheatgrass. Seeding directly into native sod is usually not successful. However, if the soil is sandy and likely to drift, it may be necessary to seed the crested wheatgrass without previous cultivation. Preparation of a seedbed is usually desirable. Seed should be drilled in, although on stony or rough areas the seed may have to be broadcast. Broadcasting seed is usually less successful in getting stands than drilling. Specially built drills involving heavy rollers and press wheels are being used with considerable success in seeding newly worked sod in community pastures. Under dry conditions crested wheatgrass may take 3 or 4 years to become established. Thin stands,

if not overgrazed, will set seed and gradually establish a complete cover from volunteer seedlings.

Surveys of old stands of crested wheatgrass in Western Canada usually show some invasion by weeds and native grasses to form stable associations with crested wheatgrass. This does not appear to have caused any loss of productivity of the crested wheatgrass component.

LAWNS, YARDS, AND ROADSIDES

Crested wheatgrass has been used for turf in the Brown soil zone for many years. In recent years, Russian wild ryegrass has excelled crested wheatgrass as a turf in several respects. It gives a denser cover than crested wheatgrass and stays greener in summer. Mixtures of the grasses are more suitable than crested wheatgrass alone. The Fairway cultivar of crested wheatgrass is best for turf because it is short and persistent. On small areas use 1.5 kg of seed per 100 m; on large areas this amount can be reduced to 0.5 kg per 100 m.

ACKNOWLEDGMENTS

Data from several establishments of the Research Branch, Agriculture Canada, were used in the preparation of this bulletin. Information from Agriculture Canada establishments at Indian Head, Melfort, Scott, Lethbridge, Beaverlodge, and Kamloops were used to complement observations made at the Saskatoon and Swift Current research stations.

CONVERSION FACTORS

Metric units	Approximate conversion factors	Results in:
LINEAR		
millimetre (mm)	× 0.04	inch
centimetre (cm)	× 0.39	inch
metre (m)	× 3.28	feet
kilometre (km)	× 0.62	mile
AREA		
square centimetre (cm ²)	× 0.15	square inch
square metre (m ²)	× 1.2	square yards
square kilometre (km ²)	× 0.39	square mile
hectare (ha)	× 2.5	acres
VOLUME		
cubic centimetre (cm ³)	× 0.06	cubic inch
cubic metre (m ³)	× 35.31	cubic feet
cubic metre (m ³)	× 1.31	cubic yards
CAPACITY		
litre (L)	× 0.035	cubic foot
hectolitre (hL)	× 22	gallons
hectolitre (hL)	× 2.5	bushels
WEIGHT		
gram (g)	× 0.04	oz avdp
kilogram (kg)	× 2.2	lb avdp
tonne (t)	× 1.1	short tons
AGRICULTURAL		
litres per hectare (L/ha)	× 0.089	gallons per acre
litres per hectare (L/ha)	× 0.357	quarts per acre
litres per hectare (L/ha)	× 0.71	pints per acre
millilitres per hectare (mL/ha)	× 0.014	fl. oz per acre
tonnes per hectare (t/ha)	× 0.45	tons per acre
kilograms per hectare (kg/ha)	× 0.89	lb per acre
grams per hectare (g/ha)	× 0.014	oz avdp per acre
plants per hectare (plants/ha)	× 0.405	plants per acre

630.72
C759
C 83-18E
OOAg
c.3

Knowles, R. P. (Robert Patrick),
1919-
Crested wheatgrass

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