Late Summer Seeding of Cool Season Perennial Grasses for Seed Production

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ABSTRACT

Spring-germinating perennial grasses generally will not produce seed during the first growing season in the northern Rocky mountain region of USA, and typically require two full growing seasons to produce economically harvestable seed yields. Late summer seeding may allow these species to establish before winter, and produce seed the next year. First growing season seed production was evaluated for 13 cool season perennial grass species seeded in mid-August at Kalispell (1981 and 1982), Bozeman (1985), and Moccasin (1985), Montana. Creeping foxtail (*Alopercurus arundinaceus* Poir.), intermediate wheatgrass (*A. intermedium* (Host) Beauv.), pubescent wheatgrass (*A. intermedium trichophorum* (Link) Richt.), and tall fescue (*Festuca arundinacea* Schreb.) produced good to excellent seed yields the first growing season. Meadow bromegrass (*Bromus biebersteinii* Roem. and Schult.), and Russian wildrye (*Elymus junceus* Fisch.), thickspike wheatgrass (*A. dasytachyum* (Hook) Scribn.), and western wheatgrass (*A. smithii* Rydb.) generally established well, but had low or erratic first growing season seed yields. Other species, Altai wildrye (*E. anagustus* Trin. ex Ledeb.), beardless wildrye (*E. triticoides* Buckl.), bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scrib. and Smith), Kentucky bluegrass (*Poa pratensis* L.), and orchardgrass (*Dactylis glomerata* L.), did not consistently establish acceptable stands.

Additional index words: **herbage seed production, sowing date, establishment, winter survival.**

INTRODUCTION

Low seed yield potential, stand failures, and high establishment costs limit perennial grass seed production in the northern Rocky mountain region of USA. Establishing perennial grasses for seed production usually involves: 1) preparing a seedbed; 2) seeding the grass species in late autumn (fall) or early spring; and 3) an establishment period of one full growing season. The first seed crop is typically harvested in the second growing season. Reducing the time interval from seeding to first seed harvest by one year would greatly improve the economics of perennial grass seed production in the northern Rocky mountain region.

Seeding perennial grasses in late summer advanced the first forage harvest by one year when autumn conditions were suitable for seed germination and seedling growth at Miles City, Montana (White and Currie, 1981). Crested wheatgrass (*Agropyron desertorum* (Fisch. ex Link.) Schult.), pubescent wheatgrass, and Russian wildrye seedlings having at least three to five leaves when spring growth was initiated, established mature stands during the first growing season. In the moderate climate of southcentral Washington, several cool season perennial grasses planted in March and late September of the same year produced similar first harvest seed yields, except for orchardgrass (cocksfoot) and tall fescue which yielded less when seeded in September (van Keuren and Canode, 1963).

Grass seedlings vary by cultivars within species in the maturity required to respond to floral inducement by cooler temperatures and/or shorter photoperiods (Canode, Anwar Muan and Teare, 1972; Nittler, Kenny and Osborne, 1963; Templeton, Mott and Bula, 1961). Therefore, not all cool season grass species seeded in late summer will be mature enough to respond to autumn floral inducing stimuli and will not produce seed the first full growing season. Seedling maturity for floral inducement is critical for cultivars of orchardgrass and tall fescue.

Grass seedling winter kill often occurs in the chinook zone of the northern Rocky mountains and plains. White and Currie (1980 and 1981) found spring growth rate and first growing season survival of crested wheatgrass, pubescent wheatgrass, and Russian wildrye seedlings increased as autumn seedling development increased up to the third leaf stage and a plant height of 6.3 cm prior to autumn dormancy.

The objective of this study was to evaluate the potential of several cool season grass species to produce seed the succeeding growing season when planted in late summer (mid-August).

MATERIALS AND METHODS

These studies were conducted at three Montana agricultural research facilities: Northwestern Agricultural Research Centre, Kalispell; the Arthur Post Field Research Laboratory, Bozeman; and the Central Agricultural Research Centre, Moccasin. Pertinent climatic and soils information is presented in Table 1.

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Table 1. Climatic and soils information for grass seed production sites at Kalispell, Bozeman, and Moccasin, Montana.

Location: Character	Kalispell Year: 1981, 1982	Bozeman 1985	Moccasin 1985
First Autumn Frost[1] (avg.)	Sept. 14	Sept. 15	Sept. 16
Frost Free Period (avg.)	111 d	107 d	114 d
Annual Precipitation (avg.)	49.3 cm	45.7 cm	38.9 cm
Altitude	896 m	1454 m	1307 m
Soils			
Series	Flathead	Amsterdam	Judith
Family	Pachic Haploxerolls	Typic Haploborolls	Typic Calciborolls
Texture Class	fine sandy loam	fine silt loam	fine loamy loam
Management	irrigated	irrigated	rainfed

[1]0°C frost

The species evaluated were: Altai, beardless, and Russian wildryes; bluebunch, intermediate, pubescent, thickspike, and western wheatgrasses; creeping foxtail; Kentucky bluegrass; meadow bromegrass; orchardgrass; and tall fescue. Ten grass species were seeded in mid-August in four row plots 7.3 m long with the rows 60 cm apart. Seeding rate was 0.8 to 1.0 PLS cm^{-1} of row. Plots were arranged in a randomised complete block design with four replications. Study sites in Kalispell and Bozeman were fallowed prior to seeding the grasses. At Moccasin, the grasses were seeded into undisturbed spring barley residue. The first post seeding frost (0°C) at Kalispell 1981 and 1982, Bozeman 1985, and Moccasin 1985 occurred on September 24, 20, 20, and 6, respectively. Supplemental fertiliser was applied to each site (Table 2). Weed control was achieved by hand weeding. Kalispell and Bozeman sites received supplemental water prior to anthesis of the grass by sprinkler and flood irrigation, respectively. At Kalispell 10 cm of water was applied each year and at Bozeman sufficient water was applied to recharge the rooting zone. Seed yields were determined by hand harvesting 2.4 m of two centre rows at physiological maturity of each species. Seed was cleaned with a combination of cylinders, hand threshers, and fanning mills.

Table 2. Fertiliser application schedule for late summer seeding of perennial grasses for seed production.

Location	Dates Applied	N[1]	P[2]
		nutrient (kg ha^{-1})	
Kalispell 1981	autumn 1981	56	45
	spring 1983[3,4]	76	29
	autumn 1983	78	0
Kalispell 1982	spring 1983[4]	76	45
	autumn 1983	78	0
	autumn 1984	78	21
Bozeman 1985	preplant	0	112
	autumn 1985	84	0
Moccasin 1985	with seed	6	12
	autumn 1985	67	0
	autumn 1986	67	0
	autumn 1987	67	0

[1]N = nitrogen as urea was broadcast except for ammonium nitrate with seed at Moccasin.
[2]P = phosphorous as P_2O_5.
[3]50 kg ha^{-1} of sulphur was broadcast as SO_4.
[4]55 kg ha^{-1} of potassium was broadcast as K_2O.

Data were analysed by analysis of variance and means separated by least significant difference to evaluate species seed yield at each location.

RESULTS AND DISCUSSION

Late summer seeding of cool season perennial grasses for seed production can be considered successful if stand establishment and winter survival is high and weed invasion is minimal. The economic threshold seed yield for late summer seeding occurs when the variable harvesting and marketing costs are less than the gross return from the first year seed crop. Creeping foxtail and other species with high value seed have a lower economic threshold yield. In this region, grass seed yields greater than 112 kg ha^{-1} are generally considered economic to harvest.

Late summer seeding did not adversely affect stand establishment and winter survival for most species. However, notes on visual observations indicate that Altai wildrye, beardless wildrye, bluebunch wheatgrass, Kentucky bluegrass, and orchardgrass had deficient first growing season stands at one or more locations. This was not surprising because: orchardgrass is susceptible to winter kill even in established stands; Altai and beardless wildryes germinate erratically and usually are difficult to establish; and bluebunch wheatgrass is often slow to establish. With some species, for example Kentucky bluegrass at Kalispell (1982) and bluebunch wheatgrass at Moccasin, a poor first growing season stand developed into an acceptable stand by the second growing season. Low or no seed production by these species usually reflected poor stand establishment.

The Kalispell site (Tables 3 and 4) produced the highest seed yields the first year and the total yield for three years across all species tested. In the Kalispell 1981 nursery (Table 3), of the species which established good stands, only Russian wildrye first year seed yields were not high enough to make harvest feasible. Russian wildrye is not adapted to the high soil water conditions which were present at the Kalispell site. In the Kalispell 1982 nursery (Table 4), only tall fescue, intermediate wheatgrass, and Altai wildrye produced clearly acceptable yields, whereas creeping foxtail and meadow bromegrass produced yields of 97 and 94 kg ha^{-1}, respectively. Intermediate wheatgrass had the highest first year average, 1259 kg ha^{-1}, across the two Kalispell nurseries. The three-fold yield advantage the Kalispell 1981 nursery had over the 1982 nursery, across all species, was presumably due to the autumn vs. spring timing of nitrogen fertiliser application (Table 2).

Table 3. Seed yield of late summer seeded grasses at Kalispell, Montana[1].

Cultivar and Species	1982	1983	1984	Total
		seed yield (kg ha^{-1})		
Garrison creeping foxtail	150	243	85	478
Kenmont tall fescue	1344	2792	587	4723
Troy Kentucky bluegrass	206	912	280	1398
Regar meadow bromegrass	684	1485	67	2236
Chinook orchardgrass	307	476	194	977
Oahe intermediate wheatgrass	1860	335	317	2512
Critana thickspike wheatgrass	421	0	42	463
Vinall Russian wildrye	0	86	6	92
Rosana western wheatgrass	196	398	63	657
Shoshone beardless wildrye	0	21	0	21
LSD ($P < 0.05$)	264	276	69	

[1] Planted: 18-8-1981

Winter injury and cool growing season temperatures contributed to low first year seed yields at Bozeman (Table 5). Only four species (creeping foxtail, tall fescue, pubescent wheatgrass, and thickspike wheatgrass) had acceptable first year yields. Total seed yields over the three years were low due to low nitrogen fertility. The only supplemental nitrogen fertiliser was the 84 kg ha^{-1} applied in the autumn of 1985.

Table 4. Seed yield of late summer seeded grasses at Kalispell, Montana[1].

Cultivar and Species	1983	1984	1985	Total
		seed yield (kg ha^{-1})		
Garrison creeping foxtail	97	409	273	779
Kenmont tall fescue	273	914	1552	2739
Troy Kentucky bluegrass	0	652	285	937
Regar meadow bromegrass	94	703	159	956
Chinook orchardgrass	0	0	72	72
Oahe intermediate wheatgrass	658	386	474	1518
Critana thickspike wheatgrass	60	436	173	669
Rosana western wheatgrass	27	249	287	563
Prairieland Altai wildrye	306	197	503	1006
Secar bluebunch wheatgrass	0	0	0	0
LSD ($P < 0.05$)	105	314	309	

[1] Planted: 25-8-1982

Table 5. Seed yield of late summer seeded grasses at Bozeman, Montana[1].

Cultivar and Species	1986	1987	1988	Total
		seed yield (kg ha-1)		
Garrison creeping foxtail	110	57	29	196
Kenmont tall fescue	108	124	41	273
Troy Kentucky bluegrass	0	0	0	0
Regar meadow bromegrass	67	77	22	146
Chinook orchardgrass	0	0	0	0
Greenleaf pubescent wheatgrass	938	73	0	1011
Critana thickspike wheatgrass	103	50	1	154
Rosana western wheatgrass	52	41	1	94
Prairieland Altai wildrye	0	0	0	0
Secar bluebunch wheatgrass	1	28	11	40
LSD ($P < 0.05$)	84	30	16	

[1] Planted: 18-8-1985

Seed yields were higher than anticipated at Moccasin (Table 6) for both the first (1986) and second-year (1987) harvests, due to an unusually favourable precipitation pattern which greatly enhanced germination and establishment. Precipitation in August of 1985 was 13.5 cm, contrasting sharply with the seventy-six year average of 4 cm. Three species produced economic seed yields the first year; creeping foxtail, tall fescue, and pubescent wheatgrass. The other species with good stand establishment (meadow bromegrass, orchardgrass, thickspike wheatgrass, and western wheatgrass) produced less than 46 kg ha^{-1} of seed. The 1988 seed yields were depressed by extremely high June air temperatures and for five species were similar or less than the 1986 first harvest yields.

Table 6. Seed yield of late summer seeded grasses at Moccasin, Montana[1].

Cultivar and Species	1986	1987	1988	Total
		seed yield (kg ha-1)		
Garrison creeping foxtail	94	199	152	445
Kenmont tall fescue	141	1113	95	1349
Troy Kentucky bluegrass	12	280	71	363
Regar meadow bromegrass	11	268	0	279
Chinook orchardgrass	30	190	39	259
Greenleaf pubescent wheatgrass	194	271	20	485
Critana thickspike wheatgrass	41	196	0	237
Rosana western wheatgrass	0	152	0	152
Prairieland Altai wildrye	0	22	128	150
Secar bluebunch wheatgrass	0	287	223	510
LSD ($P < 0.05$)	31	169	40	

[1] Planted: 22-8-1985

Late summer seeding is a viable option for establishing intermediate, pubescent, thickspike, and western wheatgrasses, tall fescue, creeping foxtail, Russian wildrye, and meadow bromegrass in the intermountain regions of Montana, provided there is sufficient soil water for germination and establishment. Intermediate and pubescent wheatgrasses, creeping foxtail, and tall fescue consistently produced economically harvestable first growing season seed yields. Altai wildrye, orchardgrass, and Kentucky bluegrass can often produce acceptable yields in the first growing season if a viable stand is established. However, Altai and beardless wildryes, bluebunch wheatgrass, Kentucky bluegrass and orchardgrass frequently established poor stands when seeded in late summer. Planting orchardgrass and Kentucky bluegrass in late summer is more risky because they are more susceptible to winter kill. Winter sensitive species should not be seeded in late summer unless there is protection provided against winter kill.

Seeding into undisturbed crop residue has been demonstrated to increase winter survival (Aase and Siddoway, 1979). However, problems with seed placement, lack of soil moisture, and volunteer cereals can be encountered when seeding into undisturbed cereal residues. Harvesting the preceding cereal for hay rather than grain would permit earlier harvest, provide weed control and seed removal, and increase the probability of available stored soil water for successful late summer establishment.

Benefits and management opportunities provided by late-summer seeding of perennial grasses include: 1) allowing for spring tillage to stimulate weed seed germination and decrease the weed seed reserves; 2) controlling annual weeds during the peak germination period with tillage or non-selective herbicides; 3) providing the opportunity to treat late emerging perennial weeds such as Canada thistle (*Cirsium arvense* L.) and bindweed (*Convolvulus arvensis* L.) with glyphosate; 4) providing the opportunity to produce an additional short-season crop before seeding the grass; and 5) the opportunity to react more quickly to higher grass seed prices.

CONCLUSIONS

Late summer seeding is a viable means of establishing some cool season perennial grasses in the intermountain areas of the northern Rocky mountain region. Intermediate and pubescent wheatgrasses, creeping foxtail, and tall fescue will generally produce sufficient seed the first growing season to provide an economic advantage over the traditional system of planting perennial grasses in the early spring or late autumn. Meadow bromegrass, thickspike and western wheatgrasses, and Russian wildrye establish well when seeded in late summer, but first year seed production levels are marginal or low. Altai and beardless wildryes, and bluebunch wheatgrass, orchardgrass and Kentucky bluegrass have some establishment and/or winter survival difficulties. Sufficient soil water is required to ensure immediate germination and emergence. Delayed emergence and establishment increase the risk of stand failure due to winter kill or increased competition from weeds. Late summer seeding provides agronomic and economic opportunities for perennial grass seed production.

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