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# Morphological Analysis of S9240 Tetraploid Crested Wheatgrass (*Agropyron cristatum*)

Angus Mellish<sup>1,2</sup> and Bruce Coulman<sup>1</sup>

<sup>1</sup>AAFC, Saskatoon Research Center, 107 Science Place, Saskatoon, SK. S7N 0X2

<sup>2</sup>Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK.

S7N 5A8

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## Abstract

S9240 crested wheatgrass was produced by colchicine-doubling the chromosome number of diploid *A. cristatum* cv. Parkway, followed by several cycles of selection for height, seed size, floret fertility, and forage yield. Some inclusion of tetraploid *A. cristatum* cv. Kirk germplasm occurred during the selection cycles. The goal of this study was compare S9240 with other crested wheatgrass cultivars in seed size, height, crown width, tiller number, tiller weight, and ability to emerge from deep seedings. The seed weight of S9240 was significantly ( $p < 0.05$ ) heavier than other tested crested wheatgrass cultivars. In seedings in greenhouse soil flats at a 7.5 cm depth, S9240 showed higher emergence and larger seedlings. S9240 was significantly ( $p < 0.05$ ) taller than other crested wheats in both spaced-plantings and solid swards, and had narrower crowns and fewer, heavier tillers. From the results of the present study, and associated yield trials, S9240 shows potential as a productive hay-type cultivar of crested wheatgrass that can emerge from deeper seedings.

**Key Words:** Crested Wheatgrass, seed size, seedling emergence.

## Introduction

The *Agropyron* genus consists of persistent, drought resistant tussock grasses which originate from the steppes of central Asia (Rogler and Lorenz, 1983). The two species of this genus which are most important in rangelands are fairway crested wheatgrass (*Agropyron cristatum* (L.) Gaertner ) and standard crested wheatgrass (*Agropyron desertorum* (Fisch. ex Link) Schlut). Smoliak and Dormar (1985) estimated that there were approximately 1 million hectares of *A. cristatum* in use as rangeland in western Canada. Mayland *et al.* (1992) estimated that there were over 6 million hectares of *Agropyron spp.* in production in North America. The fairway type is predominant in Canada while the standard type is more commonly grown in the United States.

S9240 is a crested wheatgrass that is derived primarily from a limited number of colchicine doubled, diploid, *A. cristatum* cv. Parkway plants. In addition some tetraploid *A. cristatum* cv. Kirk germplasm was included. It has been subjected to recurrent selection for increased height, high floret

fertility and large seed size. It has the upright growth of Kirk and the *A. desertorum* type, but has a broad seed head, which is the distinguishing character of the *A. cristatum* type plants.

Jefferson (1993) found autotetraploid Russian wildrye (*Psathyrostachys juncea* (Fisch.) Nevski) had a smaller number of larger tillers when compared to diploid lines. Similar results were found in when diploid orchard grass (*Dactylis glomerata* L.) was compared to tetraploid lines (Breatgnolle and Lumaret 1995).

It is often the case that range grasses are established under less than ideal conditions, with moisture being the limiting factor (Hunt and Miller, 1965). The depth at which proper moisture is present is often beyond the depth from which small seeded grasses can emerge. Rogler (1953) stated that poor emergence in crested wheatgrass (*A. desertorum*) was observed after seeds were planted deeper than 1 inch. Jefferson (1993) found, in a comparison of tetraploid and diploid Russian wildrye, that tetraploid strains had much larger seeds. Berdahl and Ries (1997) associated the larger cell size in tetraploid seeds to improved seedling vigor. Rogler (1953) conducted a study on the effects of seed size on the depth of emergence of *A. desertorum*. He concluded that large seeded plants would have a greater chance of establishing when planted at 1 inch.

The objectives of this study were to compare S9240 crested wheatgrass to other common crested wheatgrass cultivars in seed size, plant height, row width, tiller number, tiller weight and ability to emerge from deeper seedings

## **Materials and Methods**

### **Field Trials:**

Trials were conducted at the research farm of Agriculture and Agri-Food Canada (AAFC) Saskatoon Research Center. Two sward seeded trials were used for compiling data. A five year old trial which had five replications and a two year trial which had four replications. These plots were 1.25m x 6 m and were seeded at a rate of 100 seeds/m with rows spaced 30 cm apart.

Four lines were examined in the five year old trial; Parkway, Kirk, CD-II and S9240. Parkway is a diploid *A. cristatum* developed by AAFC. Kirk is a tetraploid *A. cristatum* derived, by AAFC, from an introduction from Finland. CD-II is a tetraploid intraspecific hybrid of *A. cristatum* and *A. desertorum* developed by USDA. There were three lines in the two year old trial; CD-II, Kirk and S9240.

When measuring row width and plant height, four random points were selected within each plot. The height of the tallest tiller was measured after anthesis. The distance between the outermost tillers was measured to determine the row width after the plots had been harvested. The two year old stand was harvested for forage while the five year old stand was harvested for seed.

To determine tiller density, three random locations were chosen and the number of tillers in a 10

cm section of the row counted. This number was converted to tillers per square meter. This measurement was taken after harvest in both trials.

Average tiller weights were determined only in the five year old trial. Twenty tillers were collected from each plot, the seed heads removed, and the remainder of each tiller bulked and weighed.

### **Seed Emergence:**

The seed weight of S9240, Kirk, and Nordan was determined by weighing out 100 seeds. The S9240 seed was a bulk sample from a nursery harvested in 1989. The Kirk seed was a sample of breeder seed harvested in 1996, both of which were grown on the Saskatoon Research Farm. Nordan (*A. desertorum*), came from a certified seed lot purchased in 1979.

One hundred individual seeds, from each cultivar were weighed to determine the range of seed size. Seventy five seeds which fit into the following three weight classes; 1) <3.5 mg; 2)3.5-4.5 mg; 3)>4.5 mg; and 4) a population sample, were collected from each cultivar. S9240 had seeds which were included in all four ranges. Kirk and Nordan did not have any seeds which were above 4.5 mg; and thus were not included in the large seed weight category.

To determine percent emergence, the 75 seeds were planted at 1 cm spacings at a depth of 7.5 cm. Plant counts were performed at two day intervals with the final count at day twenty eight, when the seedlings were harvested and weighed. Percent emergence was corrected for germination rates. This experiment was repeated three times to provide replication.

### **Seed Size:**

Seed was harvested from the five year old sward seeded trial. The varieties collected were Parkway, Kirk, S9240 and CD-II. The seed was cleaned and weighed and a sub-sample was collected from each replication and placed in a -20 EC freezer for two months. The seed was then removed and tested for percent germination.

One hundred individual seeds from each replication were weighed and maximum, minimum and mean weights were calculated. The seed weights were divided into five categories; 0-0.9 mg, 1-1.9mg, 2-2.9mg, 3-3.9mg and 4-4.9mg.

### **Statistical Analysis:**

Analysis of variance was determined using the SAS General Linear Means procedure. Differences were considered significant at " #0.05.

### **Results and Discussion:**

### Seedling Emergence and Seedling Weight:

There were no significant differences between the emergence of S9240 and Nordan or Kirk for the population class (Table 1). In the medium size seed range Kirk had significantly better emergence than S9240, while there was no difference between S9240 and Nordan. In the small seed size there were no significant differences.

**Table 1:** Percent emergence and average seedling weight of S9240, Kirk, Nordan, and divided into four ranges based on seed weight.

	Emergence				Mean Seedling Weight			
	Pop.	Large	Medium	Small	Pop.	Large	Medium	Small
	%				mg			
S9240	33.0	34.0	25.0	11.6	71.3	69.6	41.7	42.0
Kirk	31.0	- <sup>a</sup>	46.3	32.0	39.0	-	46.0	39.0
Nordan	28.0	-	42.0	17.7	33.0	-	61.3	26.0
Mean	30.7	- <sup>b</sup>	37.8	20.4	47.8	-	49.7	35.6
LSD(0.05)	15.7	-	19.3	36.0	23.0	-	18.0	32.4

<sup>a</sup> Varieties Kirk, and Nordan had no seeds in the large seed range. <sup>b</sup> Since only one variety is included in the large seed range no LSD or range mean are available.

S9240 had heavier seedlings than Kirk, and Nordan in the overall population. (Table 1).S9240 seedlings were larger than Nordan but not Kirk in the medium weight range. In the small weight range, there were no differences.

Even though Kirk had superior seed emergence in the medium weight ranges it was not significantly better than S9240 in the population class. This could be due to the larger portion of S9240 seeds in the medium and heavy weight range (Table 2). S9240 had 74% of its seed larger than 3.5 mg while Kirk only had 15% larger than 3.5 mg.

**Table 2:** Percentage of seeds of S9240, Kirk, and Nordan in three weight ranges

	S9240	Kirk	Nordan
<3.5 mg	26	85	42
3.5 -4.5 mg	44	14	50
>4.5 mg	30	1	8

S9240 mean seedling weights were heavier than those of Kirk and Nordan, indicating that the larger seeds of S9240 produce larger seedlings. Unfortunately since the seeds were grown in different years and environments the results may reflect a difference due to seed lot, as well as seed size.

### Seed Weight:

The distribution of seed weights from the seeds of cultivars harvested from the same trial/year provides a more accurate comparison. S9240 had the highest mean seed weight (table 3), followed by CD-II and Kirk. The diploid Parkway line had the lowest mean seed weight, The majority of the seeds in of Parkway were in the 1 to 1.9 mg weight range (table 3). All of the tetraploid lines had the majority of their seeds in the 2 to 2.9 mg range, ranging from 62.3% for Kirk and 46.8% for CD-II. In the 3 to 3.9 mg range S9240 had the highest percentage at 30.5%. There were few seeds in the 4 to 4.9 mg range with only S9240 and CD-II being represented in this category.

**Table 3:** Maximum, Minimum and Mean weights and Distribution of Seed Weight in Five Classes of Seeds from a Five Year Old Stand

	Max	Min	Mean	Weight Classes				
				0-0.9 mg	1-1.9 mg	2-2.9 mg	3-3.9 mg	4-4.9 mg
				%				
Parkway	27.5	6.3	13.8	17.5	76.3	5.8	0.5	0.0
CD-II	42.8	9.8	24.9	0.5	25.5	46.8	24.5	2.8
Kirk	39.5	9.3	23.9	0.8	19.0	65.3	14.3	0.8
S9240	43.5	12.5	26.8	0.0	10.3	56.8	30.5	2.5
Mean	37.1	9.6	22.2	3.8	33.9	44.8	16.1	1.1
LSD(0.05)	5.3	2.5	1.3	4.8	8.5	10.6	8.3	1.9

The high proportion of seeds in the 3 to 3.9mg range and relatively low number in the 1 to 1.9

mg range is the reason that S9240 has a higher mean weight than other crested wheatgrass lines that were grown in this trial. These samples will be used to repeat the emergence studies, thus eliminating any differential seed lot effect.

Rogler (1953) conducted a study on the effects of seed size on the depth of emergence of *A. desertorum* and he also found that heavier seeded lots had much better emergence from greater depths. Berdahl and Barker (1984) stated that emergence from deep seedings and coleoptile length was an indication of field performance in Russian Wildrye . Jefferson (1993) stated that the most visible indicator of seedling vigor is shoot biomass.

### **Row Width:**

S9240 had numerically the narrowest row width (table 4) in the five year old trial. S9240 had narrower rows than Parkway and CD-II, but was not significantly narrower than Kirk. There were no differences among Kirk, S9240 and CD-II in the two year old trial (table 4); however the ranking of row widths was consistent with the older trial. This lack of significant difference in the two year old trial could be due to the age of the stand, as the rows had not yet spread as much.

**Table 4:** Row Widths in Two Trials in 1999 (5 yr. old and 2 yr. old)

5 yr. Old		2 yr. Old	
Line	Row Width	Line	Row Width
	— cm —		— cm —
S9240	10.5	S9240	9.9
Kirk	11.8	Kirk	11.1
CD-II	14.4	CD-II	11.5
Parkway	15.3		
Mean	13.1		10.8
LSD(0.05)	2.0		1.65

**Height:**

S9240 was the tallest line in both trials (table 5). There was no difference between Kirk and CD-II in either of the trials. Parkway was shorter than all other lines in the five year old trial.

**Table 5:** Plant Heights in Two Trials in 1999 (5 yr. old and 2 yr. old)

5 yr. Old		2 yr. Old	
Line	Height	Line	Height
	— cm —		— cm —
S9240	100.3	S9240	106.3
Kirk	84.1	Kirk	93.5
CD-II	85.0	CD-II	92.0
Parkway	79.6		
Mean	86.9		97.3
LSD(0.05)	4.2		5.9

**Tiller Weights:**

9240 had heavier tillers than Parkway and CD-II(table 6). Parkway had the lowest tiller

weight, these tillers were visibly finer than other lines.

**Table 6:** Average Tiller Weights From a Five Year Old Trial in 1999.

Line	Tiller Weight
	———— g ————
S9240	1.21
Kirk	1.06
CD-II	0.97
Parkway	0.55
Mean	0.96
LSD(0.05)	0.19

**Tiller Numbers:**

In the five year old trial S9240 had the lowest number of tillers, while Parkway had the greatest number ( Table 7). Kirk and CD-II were intermediate in tiller number. In the two year old trial S9240 had the less tillers than CD–II. Sugiyama (1995) found in tall fescue (*Festuca arundinacea* Schreb.) that plants either had a larger number of small tillers or a lesser number of large tillers.



5 yr. old		2 yr. Old	
Line	Tiller/m <sup>2</sup>	Line	Tiller/m <sup>2</sup>
S9240	1570	S9240	1340
Kirk	2040	Kirk	1450
CD-II	1950	CD-II	1570
Parkway	3390		
Mean	2210		1450
LSD(0.05)	250		210

### Conclusion:

Since S9240 has both larger seed and higher seedling biomass, it may establish better in the field than other cultivars. The increased height, and more upright growth pattern of S9240 would facilitate mechanical harvesting of the forage crop. This would make S9240 suited as a hay type crested wheatgrass

### Acknowledgments:

The technical support of Cheryl Duncan, Bruce Hesselink and Nancy Melnychuk in conducting these experiments were greatly appreciated. The funding was provided by the Canada Saskatchewan Agri-Food Innovation Fund and Agriculture and Agri-Food Canada.

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