Evaluation of Traditional and Novel Species for Reducing Sediment Loss in North Central Indiana

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Objectives

- Phase 1: Identify alternative and novel vegetation for use in low-maintenance utility areas (e.g. outer golf course rough areas and buffer strips) that establish quickly, have excellent winter persistence and require little supplemental maintenance (e.g. mowing) for the upper cool-humid region of the United States.
- Phase 2: Quantify sediment losses from sloped areas during seedling establishment for selected promising vegetation that consist of various differential growth habits, canopy architectures across several seasonal seeding dates.

Rationale

There are increasing environmental concerns regarding the amounts of sediments, nutrients, and pesticides that are being found in our surface waters. The golf course industry has been identified as potential contributors to this growing problem because golf courses are managed intensively with fertilizers and pesticides. This problem is further intensified because golf courses are often constructed around open water sources such as oceans, seas, lakes, ponds, rivers, streams or ditches where sediment, fertilizers, and pesticides, can enter our water sources by surface runoff. To reduce this problem, current research has focused on the use of mature vegetative buffer strips near water sources that act as filters. These buffer strips have been shown to decrease contaminate losses in surface runoff. However, little scientific information exists identifying which turfgrass species and natural vegetation used in low-maintenance areas such as golf course roughs and buffering areas are effective at decreasing sediment, nutrient, and pesticide losses in surface runoff. Previous research is also limited regarding erosion control products currently available that claim to control sediment losses during the construction and establishment process.

How it was done

Phase 1(2005 & 2006): Species Evaluations

Twenty-eight species were planted at the W.H. Daniel Turfgrass Research and Diagnostic Center, West Lafayette, IN. Since sediment loss is a constant problem and many construction schedules do not always permit seeding during “optimum seeding windows”, three seeding dates were evaluated (May 15th, July 15th, and Sept. 15th). A starter fertilizer was applied at seeding at a rate of 74 kg ha-1 to enhance germination and establishment. Plots were not supplementally irrigated following the initial establishment period (60-90 days). For species evaluations, establishment rates and percentage green cover were quantified every week after seeding with visual ratings (0 to 100% linear scale). Mature plant height was quantified in five locations within each plot on three dates to measure canopy height. Stand persistence which can be correlated to winter-hardiness will be quantified by using spring green up ratings in April. The experimental design was a randomized complete-block with three replications of each species on each date and a plot size of 1.83 by 1.22 m.

Phase 2(2006): Quantifying Sediment and Runoff Losses

Surface water contamination from sediment is most severe during seedling establishment due to the lack of ground cover, slopes and potentially heavy and abrasive rainfall. Therefore, promising vegetation identified in year one will be planted on sloping soils containing both dredged and sandy soil to evaluate methods and technologies to minimize soil erosion and maximize species establishment. Runoff will be collected at the bottom of each sloped plot with a 5 gallon container to determine total runoff and sediment losses.

Results to Date:

<u>Species Evaluations</u>

Germination:

- For all three seeding dates in 2005, American sloughgrass and zoysiagrass were slower than the other species to germinate which was expected based on previous germination data (Figure 2). Switchgrass was slow to germinate in the May and September seeding dates, but germinated quickly during the July seeding which is an ideal planting time for warm-season grasses. Prairie junegrass and Kentucky bluegrass were slow to germinate during the July seeding date due to the increased temperatures.

Percent Cover:

- Three weeks after the 15 May seeding, several species had achieved 50% cover or better (Table 1): Crested wheatgrass, Dryland and Idaho bentgrass, Creeping and Meadow foxtail, K-31 tall fescue and Grande II all fescue, Hard fescue, Reed canarygrass, Canada and Foul bluegrass, as well as Weeping alkaligrass. Among these species, Crested wheatgrass, Meadow foxtail, K-31 tall fescue and Birdsfoot trefoil had achieved > 89 % cover (Figure 1).
- As expected, the slowest species to establish for the 15 May seeding were some of the warm-season species including Zoysiagrass, Little bluestem, and Switchgrass.
- Six weeks after the May seeding, all the species had achieved 80% cover or better except for Zoysiagrass.
- For the 15 July seeding, most species achieved 50% six weeks after seeding cover or better. However, American sloughgrass, Tufted hairgrass, Sheep, Chewings, and Hard fescue, Prairie junegrass, Kentucky bluegrass, and Nuttal alkaligrass had not achieved even 35 % cover by this time.
- For the 15 July seeding, species such as Crested wheatgrass, Meadow foxtail, American sloughgrass, Blue grama, Canada and Foul bluegrass, and Nuttal and Weeping alkaligrass deteriorated in quality during the summer stress period. Even ten weeks after seeding, these species never achieved 50 % cover.
- For the 15 September seeding, most of the species had achieved greater than 50 % cover after 4 weeks. However, warm-season species such as Sideoats grama, Blue grama, and Switchgrass were slower to establish than during the July seeding. Zoysiagrass never established after the 15 September seeding date.
- Cool-season grass species' Kentucky bluegrass, American sloughgrass, and Prairie junegrass were again slower to establish in the September seeding as in the previous seeding dates (15 May & 15 July) but did reach 50 % cover within 6 weeks.
- Although the autumn months of 2005 were warmer than normal for the region, the warm-season grass species exhibited a decline in percentage ground cover and quality by the November rating date as the air and soil temperatures decreased.

Spring Green-up:

- In general, the species planted in May 2005 were faster to green-up in the spring followed by the July and September seeding dates (Figure 3).
- Spring green-up ratings took place from 14 April to 24 May 2006 so it is not surprising that the warm-season species had not come back yet.

Canopy Height:

- For all three seeding dates, canopy heights were taken approximately 80 d after seeding (Figure 4-6). All of the species achieved their greatest canopy height during either the May or July seeding date.
- Big bluestem, Weeping lovegrass, and Switchgrass achieved the greatest canopy heights of 90 cm or better during the 15 May seeding date.
- For the July seeding date, Tall fescue (rhizomatous), Big bluestem, and Weeping lovegrass had canopy heights exceeding 70 cm.

Sediment and Runoff Losses

- Sediment losses were greater for the dredged soil during all three rain events (Table 2).
- Runoff losses were greater for the sandy soil for the first and third rain events but not for the second rain event were runoff losses were greater for the dredged soil.
- There were no differences in sediment loss between the tall fescue with erosion control and the bare soil with erosion control for all three rain events for both the dredged and sandy soil (Table 3).
- Sediment losses for the bare plots exceeded the tall fescue plots for run 1 for the dredged soil and run 2 for the sandy soil. For all other runs, sediment loss for the bare plots and the tall fescue plots were statistically the same.
- For the dredged soil, the bare and tall fescue plots significantly decreased runoff losses in run 1.
- For the sandy soil, runoff losses were greater for the bare plots with erosion control than the tall fescue with erosion control for only run 3.

Acknowledgements

Grateful appreciation is expressed to the Mid-West Regional Turfgrass Foundation and the Environmental Protection Agency (Region V) for their generous support of this project.

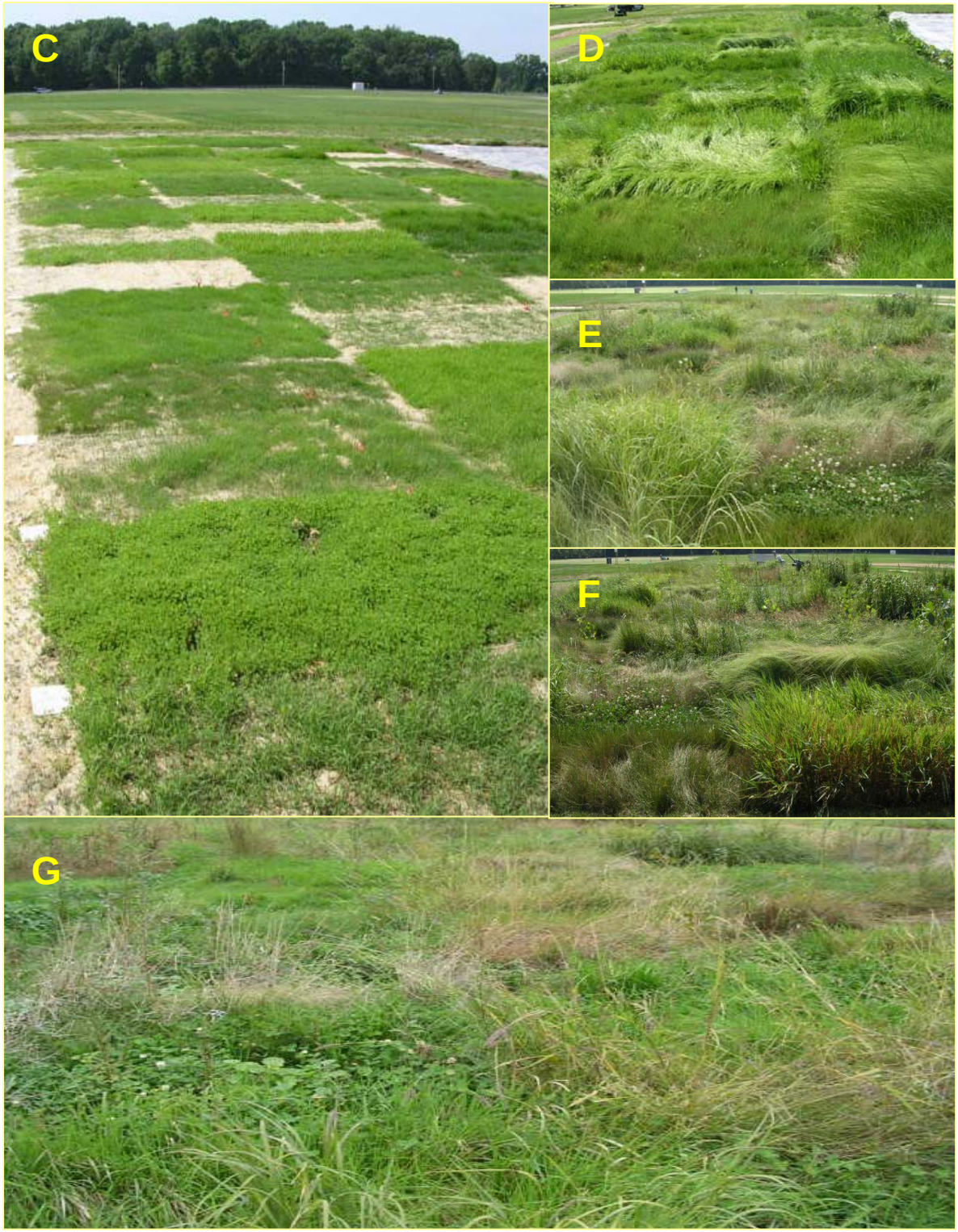
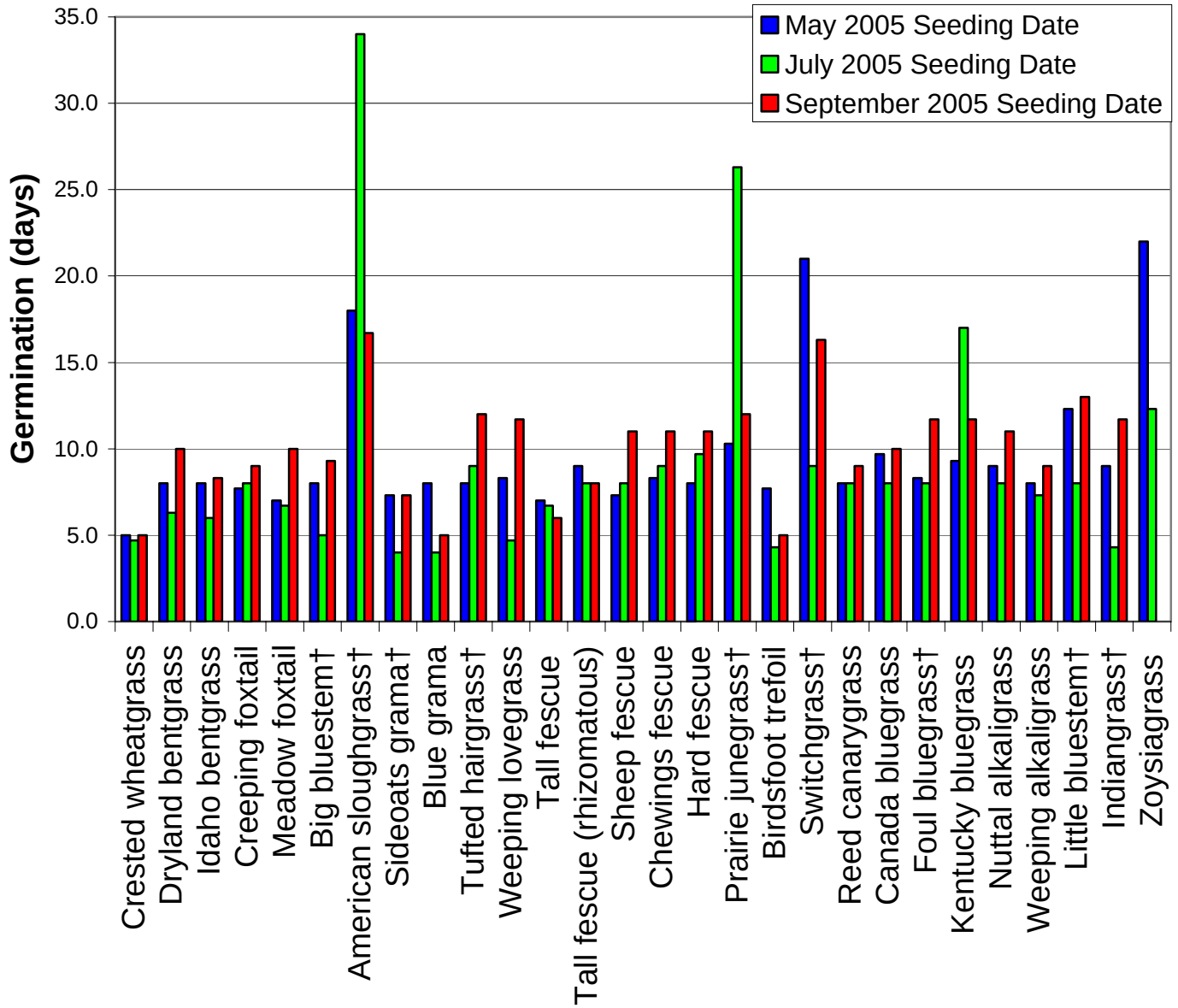


Figure 1. These photos are taken from the May 15, 2005 seeding date. Photo C was taken June 1, 2005, two weeks after planting. Photo D was taken July 1, 2005, six weeks after planting. Photo E was taken August 25, 2005, 14 weeks after planting. Photo F was taken September 1, 2005, 16 weeks after planting. Photo G was taken October 12, 2005, 21 weeks after planting.

Figure 2. Germination by seeding date in 2005 for all twenty-eight species.



†Native Species

Table 1. Establishment rate of twenty eight traditional and novel species for use in low-maintenance utility areas in North Central Indiana when seeded on three contrasting dates.

					May Seeding Date Percent Ground Cover (%)			July Seeding Date Percent Ground Cover (%)			September Seeding Date Percent Ground Cover (%)		
Treatment	**Common Name**	**Scientific Name**	**Cultivar**	**Seeding Rate (kg ha^{-1})**	**30 days**	**45 days**	**60 days**	**30 days**	**45 days**	**60 days**	**30 days**	**45 days**	**60 days**
1	Crested wheatgrass	*Agropyron cristatum*	Kirk	343	92.7	94.3	99.3	96.0	98.7	100.0	92.7	100.0	98.3
2	Dryland bentgrass	*Agrostis castellana*	Highland	49	89.7	100.0	100.0	93.3	99.3	100.0	97.0	100.0	100.0
3	Idaho bentgrass	*Agrostis idahoensis*	GolfStar	49	81.0	93.3	100.0	85.0	98.7	100.0	81.0	97.7	86.7
4	Creeping foxtail	*Alopecurus arundinaceus*	Garrison	147	100.0	100.0	100.0	68.3	86.0	98.3	96.0	100.0	100.0
5	Meadow foxtail	*Alopecurus* pratensis	VNS	196	99.3	100.0	100.0	96.0	100.0	100.0	99.3	100.0	100.0
6	Big bluestem	*Andropogon gerardi*	Kaw	392	91.0	100.0	100.0	100.0	100.0	100.0	63.3	93.7	88.3
7	American sloughgrass	*Beckmannia syzigachne*	VNS	49	23.3	98.0	100.0	0.0	15.0	28.3	16.7	50.0	40.0
8	Sideoats grama	*Bouteloua curtipendula*	Pierre	343	91.7	100.0	100.0	100.0	100.0	100.0	22.7	41.7	16.7
9	Blue grama	*Bouteloua gracilis*	Bad river	147	84.3	99.3	100.0	100.0	100.0	100.0	45.0	51.7	48.3
10	Tufted hairgrass	*Deschampsia* caespitosa	SR 6000	49	75.0	99.3	99.3	9.3	30.0	40.0	48.3	80.0	65.0
11	Weeping lovegrass	*Eragrostis curvula*	VNS	49	95.0	100.0	100.0	100.0	100.0	100.0	46.7	81.7	66.7
12	Tall fescue	*Festuca arundinacea*	Kentucky	392	100.0	100.0	100.0	97.7	89.3	95.3	100.0	100.0	100.0
13	Tall fescue (rhizomatous)	*Festuca arundinacea*	Grande II	392	95.3	100.0	100.0	91.0	93.7	100.0	98.7	100.0	100.0
14	Sheep fescue	*Festuca ovina*	MX-86	294	54.7	88.3	99.3	6.7	35.0	60.0	60.0	93.3	76.7
15	Chewings fescue	*Festuca rubra*	SR 5100	245	84.3	99.3	100.0	17.3	63.3	90.3	68.3	97.0	91.7
16	Hard fescue	*Festuca trachyphylla*	Rescue	294	76.7	86.7	99.3	7.0	26.7	36.7	36.7	76.7	60.0
17	Prairie Junegrass	*Koeleria macrantha*	VNS	49	53.3	80.0	100.0	3.7	15.0	16.7	28.3	66.7	30.0
18	Birdsfoot trefoil	*Lotus corniculatus*	Norcen	343	100.0	100.0	100.0	80.0	100.0	100.0	86.0	98.7	98.3
19	Switchgrass	*Panicum virgatum*	Shawnee	245	38.3	100.0	100.0	96.0	100.0	100.0	28.3	36.7	21.7
20	Reed canarygrass	*Phalaris arundinacea*	Palation	196	95.3	100.0	100.0	98.7	99.3	100.0	81.7	98.3	98.3
21	Canada bluegrass	*Poa compressa*	Reubens	98	91.0	97.7	100.0	63.3	58.3	63.3	96.0	99.3	100.0
22	Foul bluegrass	*Poa palustris*	VNS	49	96.7	100.0	100.0	68.3	67.7	82.7	73.3	97.0	88.3
23	Kentucky bluegrass	*Poa pratensis*	Sonic	123	85.0	97.0	100.0	5.3	18.3	26.7	41.7	93.7	81.7
24	Nuttal alkaligrass	*Puccinellia airoides*	Quill	49	91.0	90.0	100.0	31.7	36.7	9.0	68.3	92.7	86.7
25	Weeping alkaligrass	*Puccinellia distans*	Fults	98	90.0	99.3	100.0	60.0	73.3	90.3	98.7	100.0	100.0
26	Little bluestem	*Schizachyrium scoparium*	Blaze	245	43.3	90.0	100.0	82.7	95.3	97.7	53.3	51.7	33.3
27	Indiangrass	*Sorghastrum nutans*	Tomahaw	398	93.3	99.3	100.0	100.0	100.0	100.0	68.3	94.3	88.3
28	Zoysiagrass	*Zoysia japonica*	Zenith	98	1.0	40.0	100.0	88.3	99.3	100.0	0.0	0.0	0.0
$LSD_{0.05}$					**19.1**	**7.4**	**0.7**	**21.7**	**16.2**	**17.2**	**14.1**	**16.8**	**16.5**

Figure 3. Spring green-up ratings for the twenty-eight species seeded on three seeding dates.

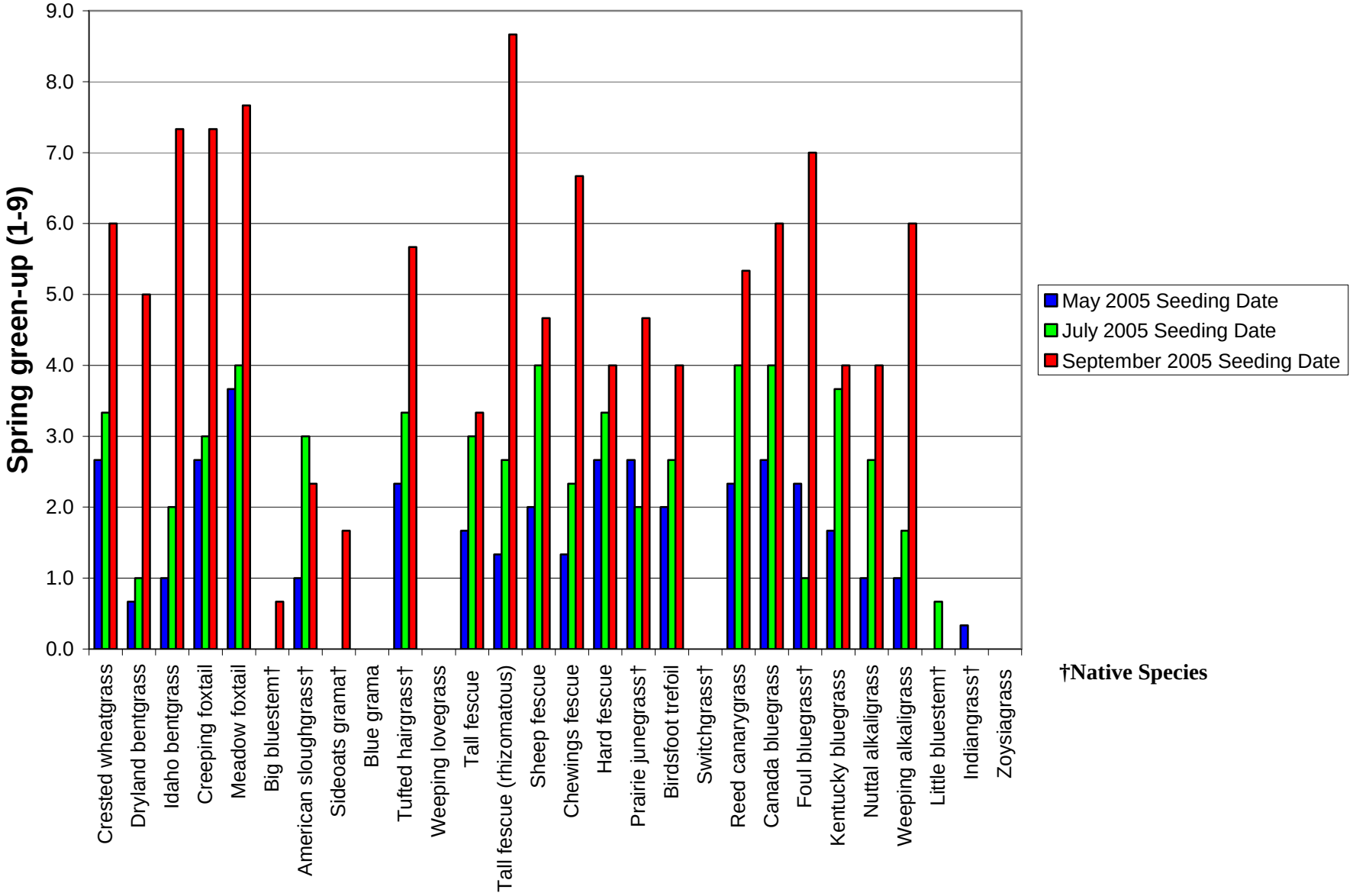


Figure 4. Canopy heights taken for the twenty-eight species approximately 80 days after the May 2005 seeding date.

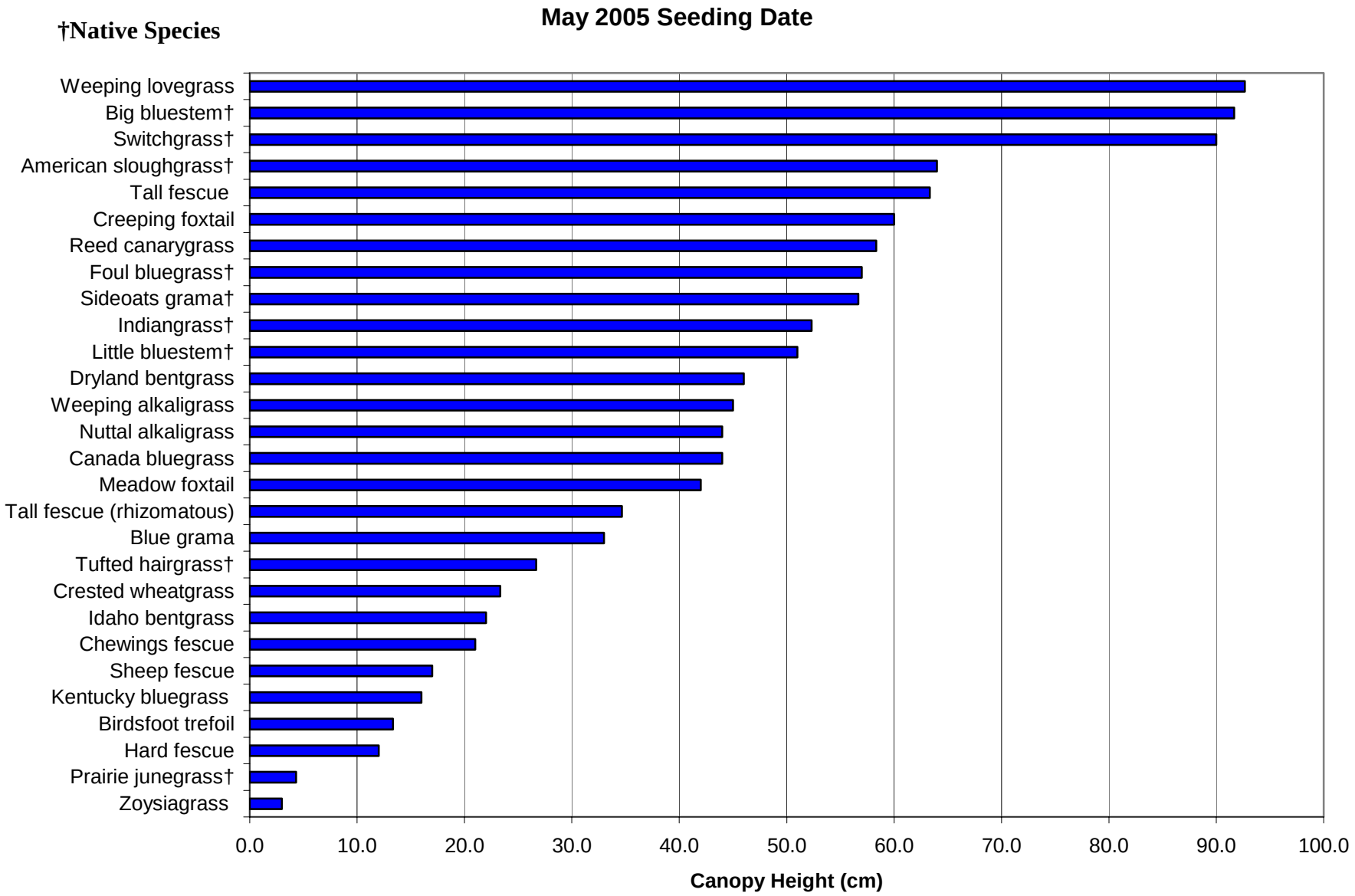


Figure 5. Canopy heights taken for the twenty-eight species approximately 80 days after the July 2005 seeding date.

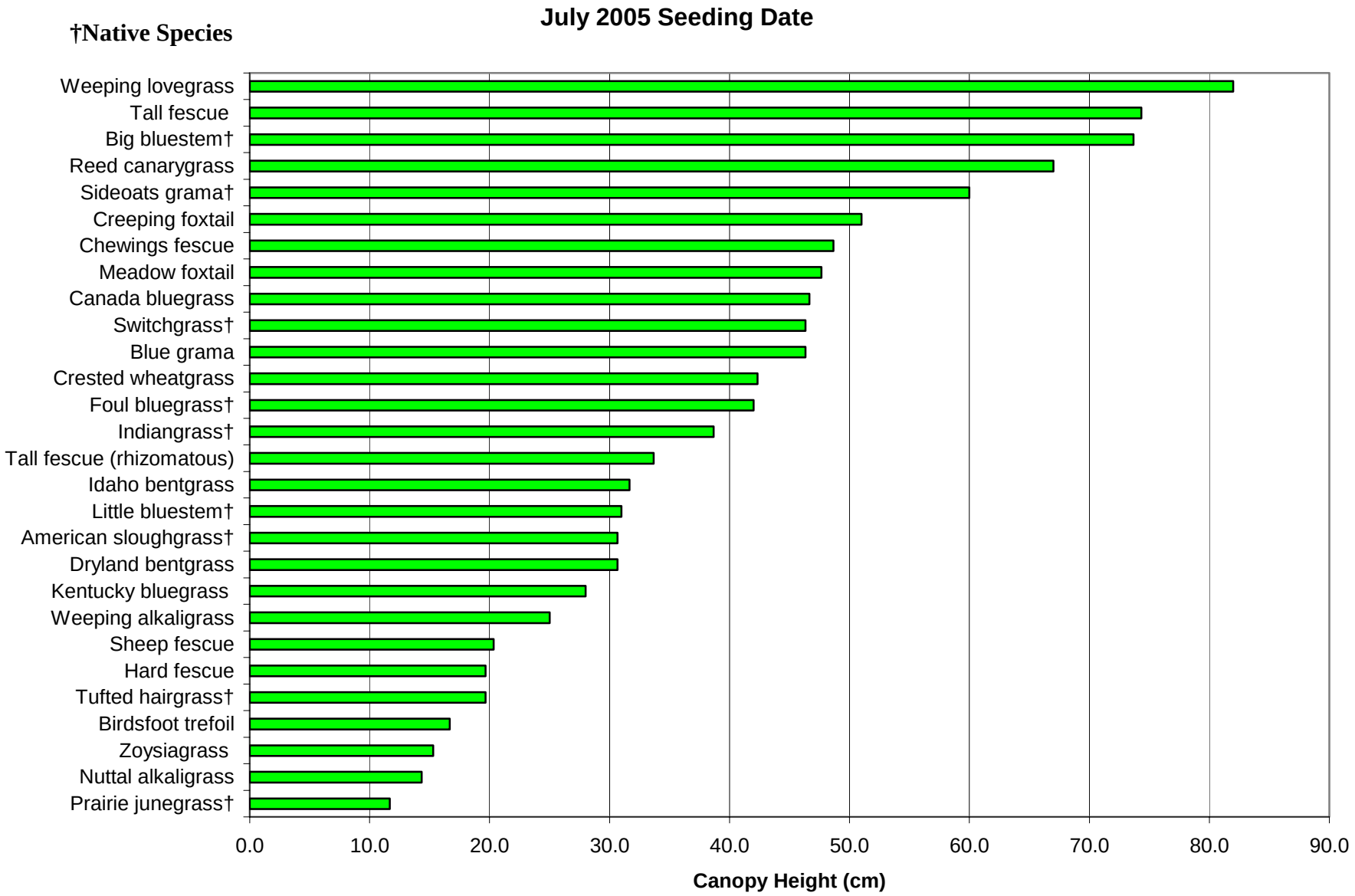


Figure 6. Canopy heights taken for the twenty-eight species approximately 80 days after the September 2005 seeding date.

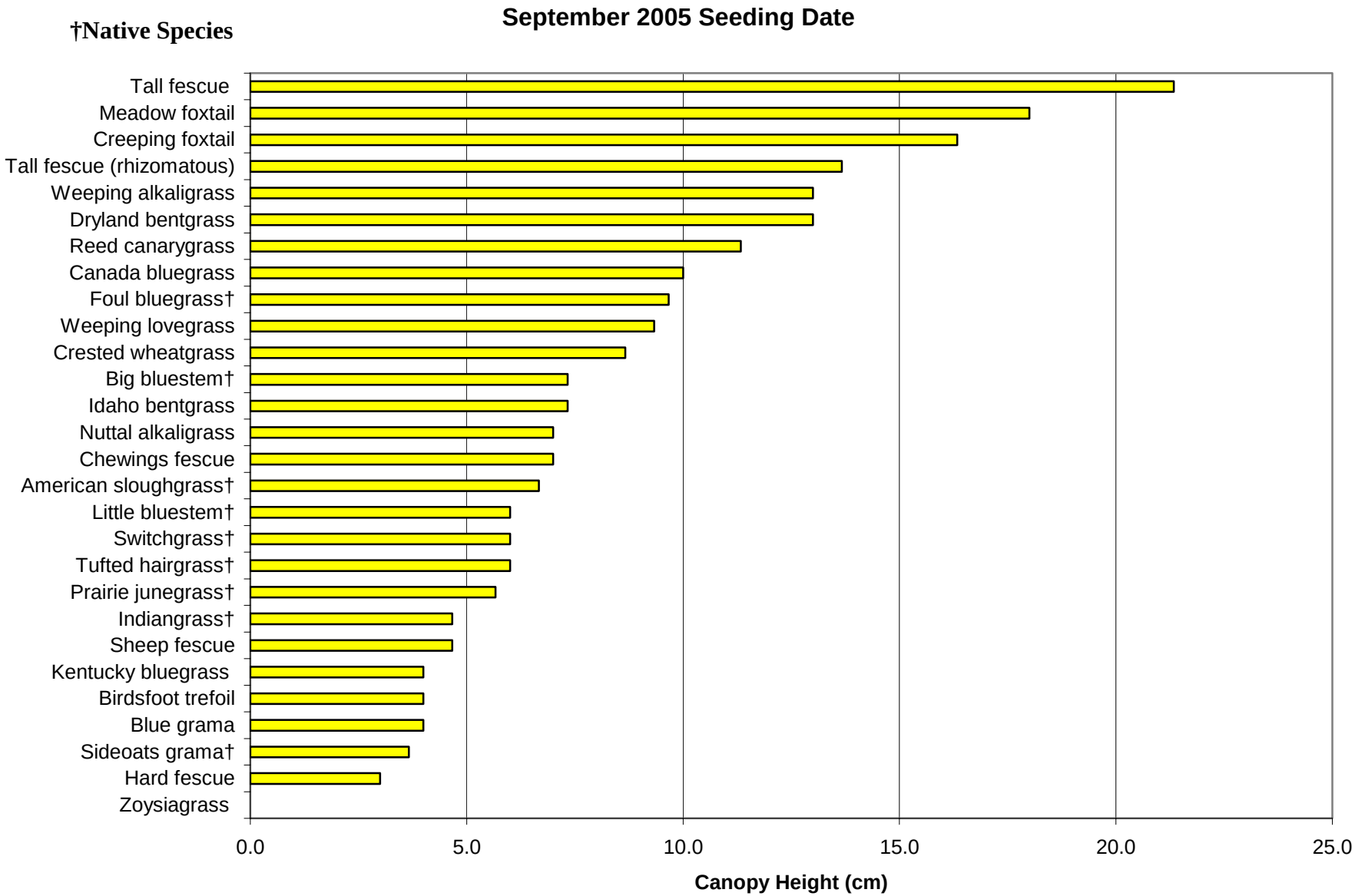


Figure 2. Promising grass species identified in 2005 were planted on runoff slopes containing dredged and sandy soil in the summer of 2006.

Dredged Soil

Sandy Soil

Table 2. Mean sediment loss and surface runoff for both the dredged and sandy soils.

Run	Soil	Sediment Loss Mg ha^{-1}	Runoff L
1	Dredged	10.5 a	8.5 b
	Sand	7.1 b	13.0 a
2	Dredged	11.2 a	11.2 a
	Sand	4.4 b	5.5 b
3	Dredged	8.1 a	4.8 b
	Sand	4.5 b	6.1 a

Table 3. Mean sediment and runoff loss with and without erosion control for bare soil and with plant cover.

Run	Soil	Treatment	Sediment Loss Mg ha^{-1}	Runoff L
1	Dredged	Tall fescue	11.1 cd	9.7 a
		Tall fescue + Erosion control	2.9 e	1.3 b
		Bare soil	14.3 ab	9.0 a
		Bare soil + Erosion control	3.6 e	1.8 b
2	Dredged	Tall fescue	13.7 a	10.7 ab
		Tall fescue + Erosion control	2.5 c	10.0 b
		Bare soil	13.9 a	11.0 ab
		Bare soil + Erosion control	3.3 c	11.5 ab
3	Dredged	Tall fescue	9.1 ab	4.8 abc
		Tall fescue + Erosion control	2.2 d	3.5 bc
		Bare soil	10.9 a	5.0 ab
		Bare soil + Erosion control	2.4 d	4.9 ab
1	Sand	Tall fescue	7.1 ab	12.4 ab
		Tall fescue + Erosion control	2.8 c	11.3 b
		Bare soil	7.8 ab	14.4 a
		Bare soil + Erosion control	3.4 c	13.6 ab
2	Sand	Tall fescue	4.6 c	5.1 cd
		Tall fescue + Erosion control	2.2 e	4.6 d
		Bare soil	5.3 a	5.2 cd
		Bare soil + Erosion control	2.3 e	6.9 a
3	Sand	Tall fescue	4.7 a	5.6 bc
		Tall fescue + Erosion control	2.8 b	6.1 b
		Bare soil	4.8 a	5.2 c
		Bare soil + Erosion control	2.9 b	8.7 a