Responses of Creeping Bentgrass to Salt Stress during In Vitro Germination

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INTRODUCTION

Creeping bentgrass (*Agrostis stolonifera*) is widely used on golf course putting greens, fairways, and other intensively managed turf facilities in northern climates because of its high turf quality and excellent tolerance of low mowing. Frequent irrigation is required for creeping bentgrass to remain functional and maintain its aesthetic qualities under intense use. Recycled water is the only water source with increasing availability and may be an alternative to potable water for turfgrass irrigation. However, excessive salts in recycled water may cause salinity/sodicity damage to turfgrasses. Use of salt-tolerant species/cultivars is one of the most economically efficient cultural practices to help remedy soil salinity effects on turf. Limited information is available on the salinity tolerance of bentgrass cultivars, especially during germination when seeds and young seedlings are more likely to be exposed to high salinity levels due to evaporation and capillary rise of water near the soil surface. Furthermore, a new generation of improved creeping bentgrass cultivars were made commercially available in the last decade, including 'Declaration' with high dollar spot (*Sclerotinia homoeocarpa*) tolerance, 'Independence' with high drought tolerance, 'T-1' and 'Alpha' with high compatibility over annual bluegrass, and '007' and 'Tyee' with high overall quality. There is interest from turfgrass managers and breeders to compare relative salinity tolerance in commercial creeping bentgrass cultivars, including the new releases.

OBJECTIVE

- Evaluate salinity tolerance of 26 commercial creeping bentgrass cultivars during germination under a controlled environment.

MATERIALS AND METHODS

- Seeds surface sterilization
  95% ethanol 1 min + 2% (v/v) sodium hypochlorite 20 min + ddH_2O rinsing
- Germination condition
  25/15 ºC (day/night) under fluorescent light (36 μmol·s^{-1}·m^{-2}) with an 8-to16-h photoperiod
- Experiment design
  Factorial combination of 12 cultivars x 5 salinity levels in a CRD
- Measurements
  Final germination rate (FGR, %) = 100 x [(∑*n*)/56]
  Daily germination rate (DGR, % d^{-1}) = 100 x [∑(*n*/*D*)]/56
  n = the number of new germinated seeds at each counting
  D = the number of days accumulated up to that counting

Table 1. Final germination rate (FGR, %) and daily germination rate (DGR, % d^{-1}) as affected by salinity.

NaCl (g L^{-1})	FGR† (%)	DGR (% d^{-1})
0	100.0 a‡	20.2 a
5	98.1 b	14.9 b
10	85.5 c	8.9 c
15	34.3 d	2.5 d
20	4.0 e	0.2 e

† Final germination rate (FGR) under saline conditions was expressed as a percentage of control (0 g NaCl L^{-1}).
‡ Means followed by the same letter in each column are not significantly different at *P*≤0.05.

RESULTS

- Final germination rate and DGR were reduced as salinity levels increased (Table 1).
- The predicted salinity levels to reduce 10 and 50% FGR ranged from 4.0 to 10.7 g L^{-1} and from 11.5 to 16.7 g L^{-1}, respectively (Table 2).
- The predicted salinity levels causing 10 and 50% reduction in DGR ranged from 1.2 to 2.7 g L^{-1} and from 6.3 to 11.0 g L^{-1}, respectively (Table 2).

Table 2. Predicted salinity levels to reduce 10 or 50% final germination rate (FGR, %) and daily germination rate (DGR, % d^{-1}) in 26 commercial creeping bentgrass cultivars.

Cultivar	FGR reduction		DGR reduction		Cultivar	FGR reduction		DGR reduction	
	10 %	50%	10 %	50%		10 %	50%	10 %	50%
	NaCl (g L^{-1})					NaCl (g L^{-1})			
Declaration	10.7 a†	16.7 a	2.7 a	10.9 a	Imperial	6.9 h	14.1 e-i	1.7 c-f	8.2 e-g
Seaside II	10.1 ab	16.4 a	2.5 ab	10.7 ab	Penncross	7.0 e-h	14.0 f-j	1.8 c-f	8.2 e-g
T-1	10.3 ab	16.2 ab	2.1 a-d	10.0 a-c	L-93	6.5 f-h	13.8 g-k	1.7 c-f	8.0 e-g
Independence	10.7 a	16.1 ab	2.1 a-d	9.9 a-c	007	5.9 h-i	13.8 g-k	1.8 c-e	8.0 e-g
Bengal	10.1 ab	16.0 ab	2.0 a-d	9.6 b-d	Penn A-1	6.6 f-h	13.8 g-k	1.6 c-f	8.0 e-g
Memorial	9.5 a-c	15.4 bc	2.0 b-e	9.5 b-d	Alister	6.1 h	13.7 g-k	1.8 c-f	7.9 e-g
Century	8.4 c-e	15.0 cd	2.1 a-d	9.1 c-e	A-4	6.1 h	13.6 h-k	1.7 c-f	7.7 f-h
MacKenzie	8.8 b-d	14.9 c-e	2.1 a-c	9.1 c-e	Crystal bluelinks	6.3 gh	13.5 i-k	1.6 c-f	7.6 f-i
Alpha	8.3 c-e	14.8 c-f	1.9 c-e	9.0 c-e	Penn G-6	5.6 hi	13.2 jk	1.5 d-f	7.5 g-j
Crenshaw	8.0 c-e	14.7 c-f	2.1 a-d	9.0 c-e	LS-44	5.5 h-j	13.1 k	1.6 c-f	7.4 g-j
Pennlinks II	7.9 d-g	14.5 d-g	1.7 c-f	8.8 c-f	Tyee	4.4 jk	11.8 l	1.4 ef	6.6 h-j
Southshore	7.9 d-g	14.4 d-h	1.9 c-e	8.6 d-g	Kingpin	3.8 k	11.5 l	1.2 f	6.4 ij
Putter	6.0 h	14.1 e-i	1.8 c-e	8.5 d-g	SR1150	4.0 jk	11.4 l	1.2 f	6.3 j

† Means followed by the same letter in each category are not significantly different at *P*≤0.05.

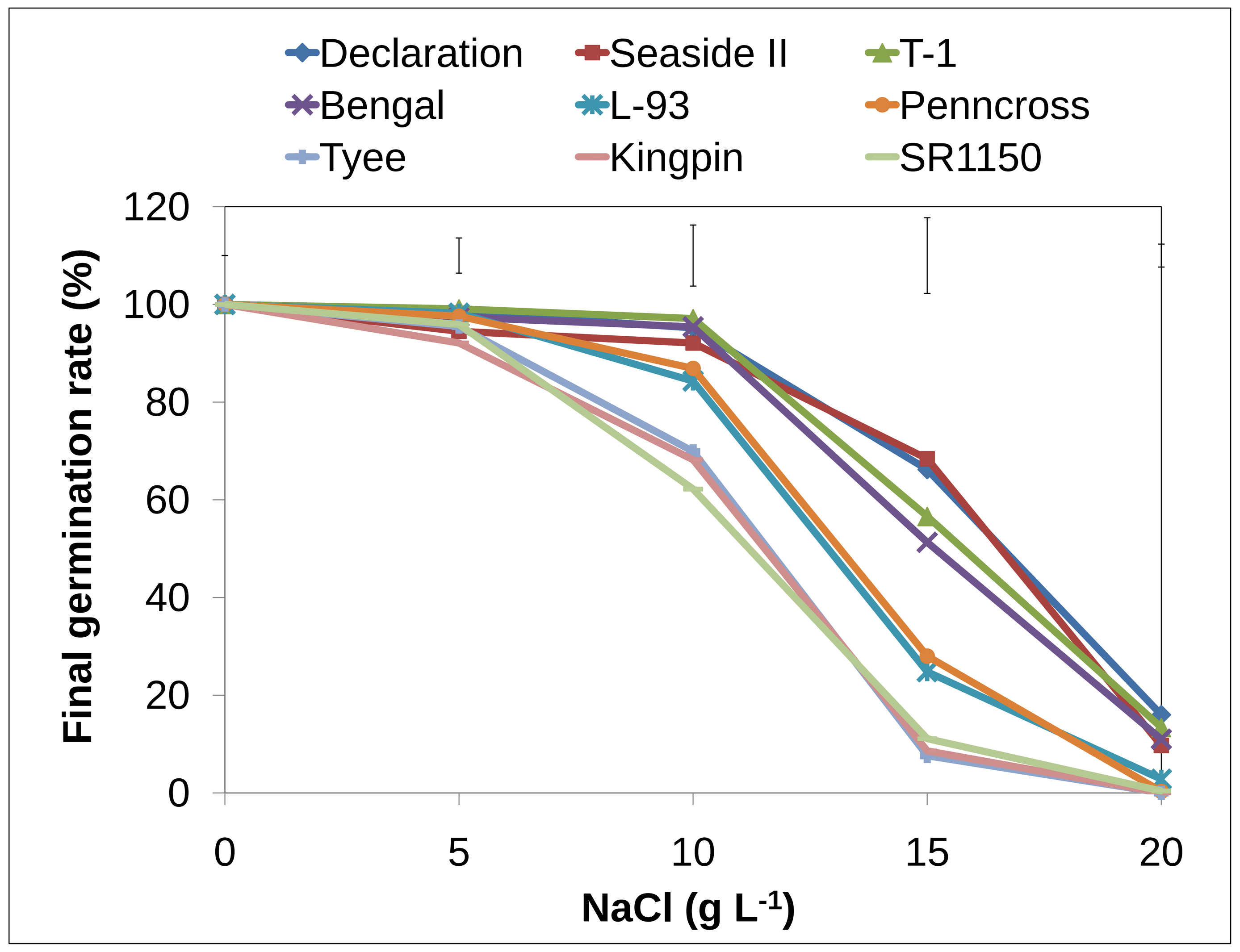

Fig. 1. Final germination rate (%) of nine representative creeping bentgrass cultivars with increasing NaCl concentrations (g L^{-1}). Final germination rate under saline conditions was expressed as a percentage of control (0 g NaCl L^{-1}) for each cultivar. Individual data points were the means of six replications in two studies. Vertical bars represent LSD at *P* ≤ 0.05.

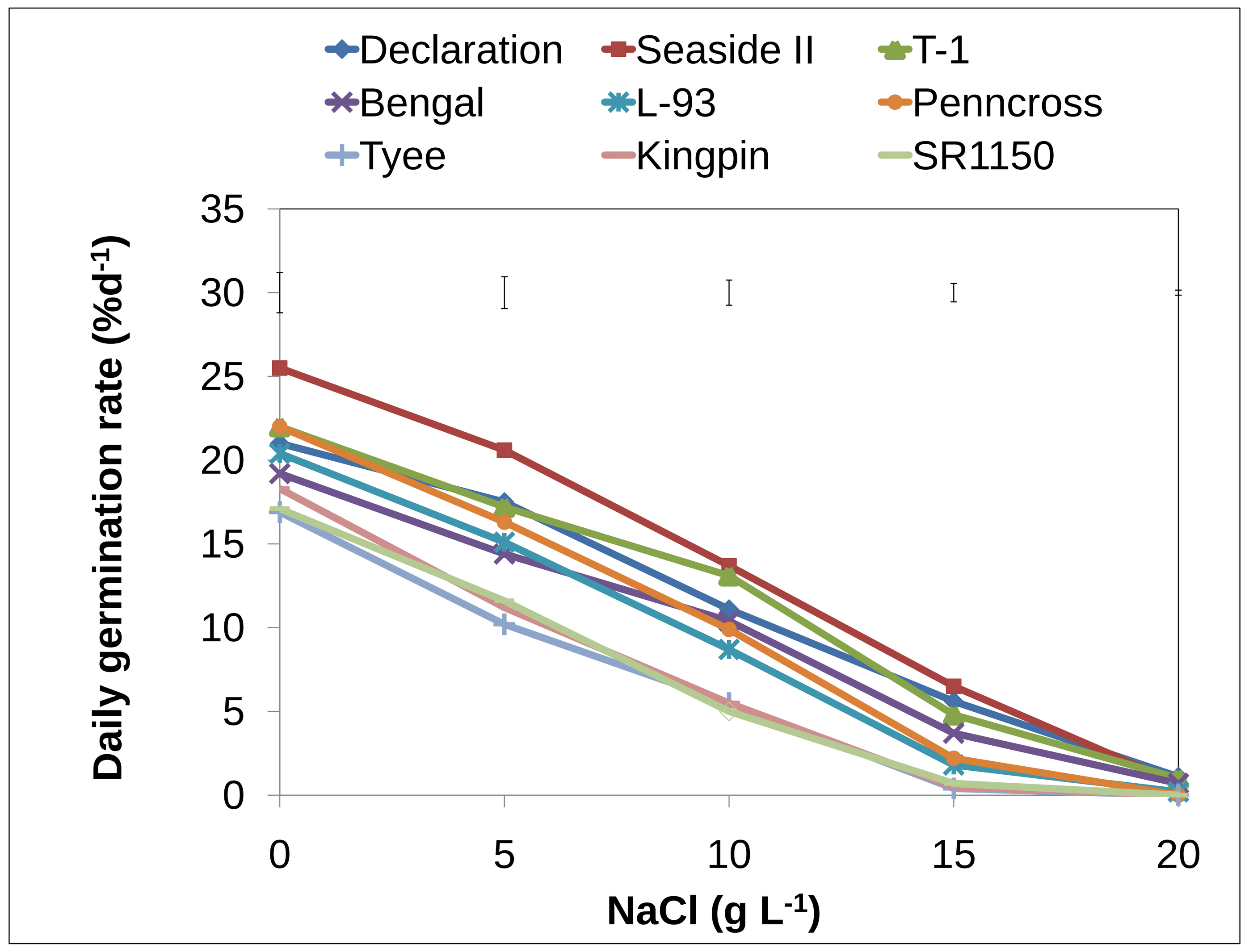

Fig. 2. Daily germination rate (% d^{-1}) of nine representative creeping bentgrass cultivars with increasing NaCl concentrations. Individual data points were the means of six replications in two studies. Vertical bars represent LSD at *P* ≤ 0.05.

CONCLUSION

- Substantial variation in salinity tolerance was observed in 26 commercial creeping bentgrass cultivars, in which 'Declaration', 'Seaside II', 'T-1', and 'Bengal' were salt tolerance; while 'Tyee', 'Kingpin', and 'SR1150' were salt sensitive (Fig. 1 and 2).
- Daily germination rate is more sensitive to saline stress compared to FGR.