Environmental Factors Influencing Germination in Seeded Seashore Paspalum

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Abstract. Seashore paspalum (*Paspalum vaginatum* O. Swartz) is a perennial warm-season grass that is rapidly gaining popularity for use on golf courses and athletic fields. The first seeded cultivar of seashore paspalum was recently developed. Seed from the pilot production of this cultivar harvested in Oregon during 2002 by Turf-Seeds, Inc. demonstrated a high level of apparent seed dormancy with a tetrazolium test of 91% but a germination rate of less than 5% at room temperature. This seed was used in laboratory experiments to determine the effect of a number of environmental factors on germination response in this new turf species. Treatment factors are germination media, constant and alternating (night/day) temperatures, and light. A strong and significant effect of temperature on germination was observed. Total germination was increased at higher temperatures. At the same daytime temperature, seed germination under alternating temperature was better than germination at constant temperature. The effect of light on germination was significant at 20, 25, 30, 20/35 °C in water and at 25/35 °C in 0.2% KNO₃ germination media. However, the effect of light on germination in KNO₃ media was not significant at 35 °C constant and 20/30 °C alternating temperatures. Alternating temperature used in conjunction with KNO₃ media reduced the requirement for light. The use of 0.2% KNO₃ rather than water as the germination media increased germination in most temperature and light treatments. Based on our results, maximum germination percentage was obtained when seed was germinated at 35 °C constant or 20/35 °C alternating temperature. However, when we consider field application, 25/35 °C with light is more realistic condition in field. Therefore, recommended seed germination test condition is at 25/35 °C with KNO₃ treatment.

Seashore paspalum (*Paspalum vaginatum* O. Swartz, $2n = 2x = 20$) is a self-incompatible warm-season perennial grass (Carpenter, 1958). Seashore paspalum can tolerate irrigation with saline water (Carrow and Duncan, 1998), waterlogging (Colman and Wilson, 1960), severe soil pH (range, 3.6–10.2; Duncan, 1994), drought (Huang et al., 1997), and low light intensity or shade conditions (Jiang et al., 2004). As a result of its aggressive and fast-growing characteristics under extremely warm and humid climates, it plays an important role in preventing soil erosion in coastal environments and has been used for the bioremediation of contaminated or unproductive soils. More recently, im-

proved cultivars of seashore paspalum have been used as a turfgrass on golf courses, sports fields (Duncan and Carrow, 1999), and as a lawn and landscape grass (Knoop, 1997) in tropical and subtropical regions.

The first seeded cultivar of seashore paspalum was recently developed and commercialized by Turf-Seed, Inc. of Hubbard, Ore. Although seeded paspalum has great potential for several commercial applications, concerns regarding low germination rate and poor uniformity of germination time have arisen. Research is needed to improve total germination and uniformity of germination; otherwise, these issues could hinder marketability and commercial success of this and future seeded paspalum cultivars.

Characterization of the environmental factors that influence germination of seeded paspalum could also provide useful information for the development of recommended cultural protocols for establishing grass field. The objectives of this study were 1) to

determine the environmental factors such as temperature and light on seed germination; and 2) to develop a seed germination testing protocol that accurately reflects the germination potential of unknown seed lots of seashore paspalum.

Materials and Methods

Seeds of 'SeaSpray' seashore paspalum used in this study were produced in a pilot production field by Turf-Seed, Inc. of Hubbard, Ore., during 2002. Tetrazolium tests conducted at Turf-Seed germination laboratory indicated 91% viable seed. Seed samples used in this study were received at our laboratory in December 2002 and maintained in storage at 4 °C before use in these experiments. Three different germination factors (germination media, temperature, and light) were tested in a $2 \times 7 \times 2$ factorial treatment design with 3 replications. Solutions of 0.2% (w/v) KNO₃ and H₂O were tested as germination media. The seven temperature treatments tested were constant temperature at 20, 25, 30, and 35 °C and alternating night/day temperature at 20/30, 25/35, and 20/35 °C. Light treatments were constant darkness (dark) and alternation (dark/light for 16/8 hours).

All germination tests were conducted in transparent $11 \times 11 \times 3.5$ -cm polystyrene germination boxes with friction-fitting lids (Hoffman Manufacturing, Inc., Albany, Ore.) and with two layers of steel blue blotter germination paper (Anchor Paper, St. Paul, Minn.). Each experimental unit consisted of 100 seeds placed on germination paper soaked in 17 mL of germination media and placed in a Conviron Model E15 growth chamber (Controlled Environments Limited, Winnipeg, Man.). The germination boxes were rearranged daily to minimize the effects of potential temperature differences within the chambers. The number of germinated seeds, defined as those with both plumule and radicle protruding through the testa, was recorded daily for 21 d. Data were statistically analyzed (SAS Institute). When the analysis of variance was significant, means were compared by least significant differences (LSD).

Results and Discussion

Significant interaction of germination media $\times$ temperature and light $\times$ temperature was found. Germination rate of seeded seashore paspalum was significantly improved in most treatments when 0.2% KNO₃ was used as germination media (Table 1). KNO₃ failed to improve germination response when germination was attempted at constant temperatures of 20, 25, and 30 °C in constant darkness. Maximum germination rates were obtained when an alternating light treatment was used at 35, 20/35, and 25/35 °C. Response to light in the 0.2% KNO₃ media was significant at 20, 25, and 30 °C but not significant at 35 and 20/30 °C.

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Table 1. The effect of environmental factors (light, temperature, and KNO₃) on the mean germination percentage of seeded seashore paspalum after 3 weeks.

Temperature	8 h light			Constant darkness		
	H ₂ O	0.2% KNO ₃	H ₂ O vs. 0.2% KNO ₃	H ₂ O	0.2% KNO ₃	H ₂ O vs. 0.2% KNO ₃
20 °C	6.3 b	18.3 d	y	0.0 c	0.7 e	—
25 °C	4.7 b	29.7 c	y	0.3 c	0.0 e	—
30 °C	12.7 b	57.7 b	y	0.7 c	6.0 d	z
35 °C	42.7 a	74.7 a	y	19.3 b	76.0 a	y
20/30 °C	8.0 b	55.3 b	y	2.7 c	50.3 c	y
20/35 °C	53.0 a	70.0 a	y	34.7 a	77.3 a	y
25/35 °C	53.0 a	77.0 a	y	20.7 b	68.7 b	y
LSD	13.3	10.6		7.5	4.7	

^{yz}Significant at $P = 0.05$ and 0.01 , respectively.

Values followed by the same letter within a column are not significantly different (LSD, $P < 0.05$).

The best germination rate was obtained with KNO₃ treatment at a constant temperature of 35 °C or at alternating temperatures of 20/35 and 25/35 °C regardless of presence of light. This finding indicates that KNO₃ in combination with higher temperature can substitute for the light. Germination rate of seeded seashore paspalum was significantly affected by temperature (Table 1). Under the constant temperature regimes, higher temperatures induced better germination rates. Final germination percentages at 20/35 and 25/35 °C were higher than germination percentages at 20/30 °C in altering temperature regimes. Germination rate at 20/30 °C was lower than germination at 20/35 °C. It indicated that germination of seeded seashore paspalum was more influenced by daytime temperature than by night temperature. Alternating temperature used in conjunction with KNO₃ reduced the requirement for light.

When seashore paspalum seeds were tested under varying germination temperatures, greatly different germination responses were observed (Fig. 1). Light, higher temperature, and KNO₃ all improved germination speed as well as final germination rate. Germination was initiated earlier at 20/35 °C when seeds were placed in KNO₃ media rather than in water. Light (alternating) also improved the rate of germination, especially when KNO₃ was used at lower germination temperatures. The highest germination rate at week 1 was 40% observed at 20/35 °C with light and KNO₃ (Fig. 1). At 2 and 3 weeks, no significant differences in germination rate were observed among the 35, 20/35, and 25/35 °C temperature treatments with light. The uniformity of germination was the highest at 20/35 °C than at 35 and 25/35 °C.

The successful establishment of turf from seashore paspalum seed is greatly dependent on the germination response to the environment. Seed germination usually occurs in the growing season after seed dormancy was being removed. Increasing temperatures, alternating temperatures, and using KNO₃ showed significant increases in germination speed and total germination. An alternating temperature of 25 °C for 16 h (darkness) and 35 °C for 8 h (d) stimulated germination and improved germination rate of seashore paspalum seeds in both water and KNO₃ media. Marousky and West (1988) reported

Fig. 1. The effect of environmental factors (light, temperature, and KNO₃) on seed germination responses in seeded seashore paspalum. KL, 0.2% KNO₃ with light; HL, H₂O with light; KD, 0.2% KNO₃ without light; HD, H₂O without light.

that paspalum species require light and alternating temperatures for maximum germination. Our results also indicated that warmer alternating temperatures were necessary for better germination rate. In water, light treatment increased germination at all temperatures. Above 30 °C is the optimum daytime temperature for germination. KNO₃ in conjunction with light showed additive effect at 20 and 25 °C constant. Germination at 20/35 and 25/35 °C in 0.2% KNO₃ media might be the best condition for germination testing. However, when we consider field application, germination at 25/35 °C with 0.2% KNO₃ treatment is more realistic condition.

Recommended test condition for seed germination is 25/35 °C with 0.2% KNO₃. However, most seeded grass varieties for golf courses and sports fields need fast germination speed and uniform germination rate. Our results indicated that only 10.3% of seeds were germinated within 1 week at recommended optimum condition. Therefore, further research is needed to improve speed and uniformity of germination for the fast establishment of grass field.

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