MODELING SEEDLING EMERGENCE OF DALLISGRASS AND BAHIAGRASS FORAGE CULTIVARS WITH AN EMPIRICAL ENVIRONMENTAL VARIABLE

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BACKGROUND

In temperate and sub-tropical regions, adoption of warm-season forage grasses has been hindered by their generally low and unpredictable seedling emergence. These species show seed dormancy which establish the proportion of seeds that could be able to germinate under certain environmental condition. Modeling seedling emergence with environmental variables may provide a better understanding of the processes involved leading to a better adjustment of sowing dates and technology. Among modeling methods, those based on thermal time and hydrotime accumulation are the most frequently used [1,2]. These methods associate germination rate or seed dormancy with temperature (T) and/or water potential (Ψ). Models based on thermal time can be developed empirically with field emergence data, where the incidence of environmental variables on seedling emergence, and its underlying processes, may be deduced without prior information.

OBJECTIVE

Develop an empirical environmental variable, based on thermal time accumulation, which can achieve a lineal model with the maximum proportion of seedling emergence, from field data of two novel *Paspalum* cultivars: *P. dilatatum* cv. INIA Chirú (Dallisgrass) and *P. notatum* cv. INIA Sepé (Bahiagrass).

MATERIALS AND METHODS

Sixteen sowings with three replicates, within irrigated and non-irrigated main plots, were carried out during two years and three locations (Table 1). Cumulative emergence was recorded weekly until no more seedlings emerged. Daily temperature and precipitation were recorded to calculate daily mean temperature (Tm) and water potential (Ψ), the last one was estimated with STM2 model [3].

Average Weighted Thermal Time ($AWTT$) is proposed as a linear regression variable of the maximum proportion of emergence:

$$AWTT = \frac{\sum_i^n [w_i \times (Tm_i - T_{low})]}{n}$$

where w_i is the weighting coefficient, Tm_i is the mean temperature of day i, and n is the number of days until no more seedling emerged. The weighting coefficient can take values between +1 and -1, and can be variable among nine thermohydric ranges defined by two temperature (T_{low} and T_{high}) and two water potential thresholds (Ψ_{low} and Ψ_{high}).

The values of w_i and the thresholds were adjusted by iteration. First, w_i values for the high water availability range and temperature thresholds were adjusted with data from irrigated plots. Then, the water potential thresholds and w_i values for the rest of the ranges were adjusted with data from non-irrigated plots, with a re-iteration of the temperature thresholds to improve adjustment.

Higher determination coefficient (r^2) was used to find the best adjustment. The slope of each linear regression was tested against null hypothesis, with an F-test. Regression, statistical analysis and plots were made in GraphPad Prisma 5.1 software.

Table 1. Sowing descriptions with site, year and sowing date. Average Tm and precipitations (PP) were calculated between sowing date and the time which no more seedlings emerged.

Site	Year	Sowing date (season)	Sowing environmental data: Average Tm (°C d^{-1})	Sowing environmental data: Average PP (mm d^{-1})
Buenos Aires,	2013	oct-21 (spring)	19.7	3.50
Argentina		nov-28 (spring)	26.2	3.53
Montevideo,	2013	apr-26 (fall)	13.6	1.83
Uruguay		oct-14 (spring)	18.4	3.32
		nov-12 (spring)	22.9	3.29
Montevideo,	2014	mar-13 (fall)	18.2	3.08
Uruguay		apr-10 (fall)	15.3	3.41
		sep-17 (spring)	17.1	4.08
		oct-15 (spring)	19.7	5.94
Salto,	2013	apr-1st (fall)	17.0	4.24
Uruguay		apr-26 (fall)	14.8	3.96
		oct-16 (spring)	21.1	7.87
Salto,	2014	mar-23 (fall)	19.1	6.63
Uruguay		may-14 (fall)	12.9	2.24
		sep-19 (spring)	18.0	6.60
		oct-21 (spring)	22.1	5.74

RESULTS

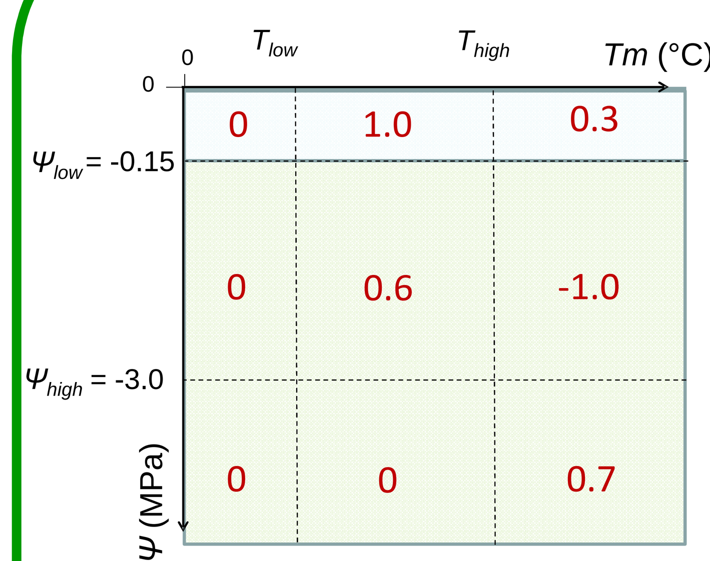

Figure 1. Adjusted w_i values for each thermohydric range defined by temperature and wáter potential thresholds (T_{low}, T_{high}, Ψ_{low} and Ψ_{high}).

Table 2: Adjusted temperature thresholds by species and irrigation treatment.

	Irrigated plots: T_{low}	Irrigated plots: T_{high}	Non-irrigated plots: T_{low}	Non-irrigated plots: T_{high}
Dallisgrass	9°C	21°C	11°C	18°C
Bahiagrass	10°C	22°C	13°C	20°C

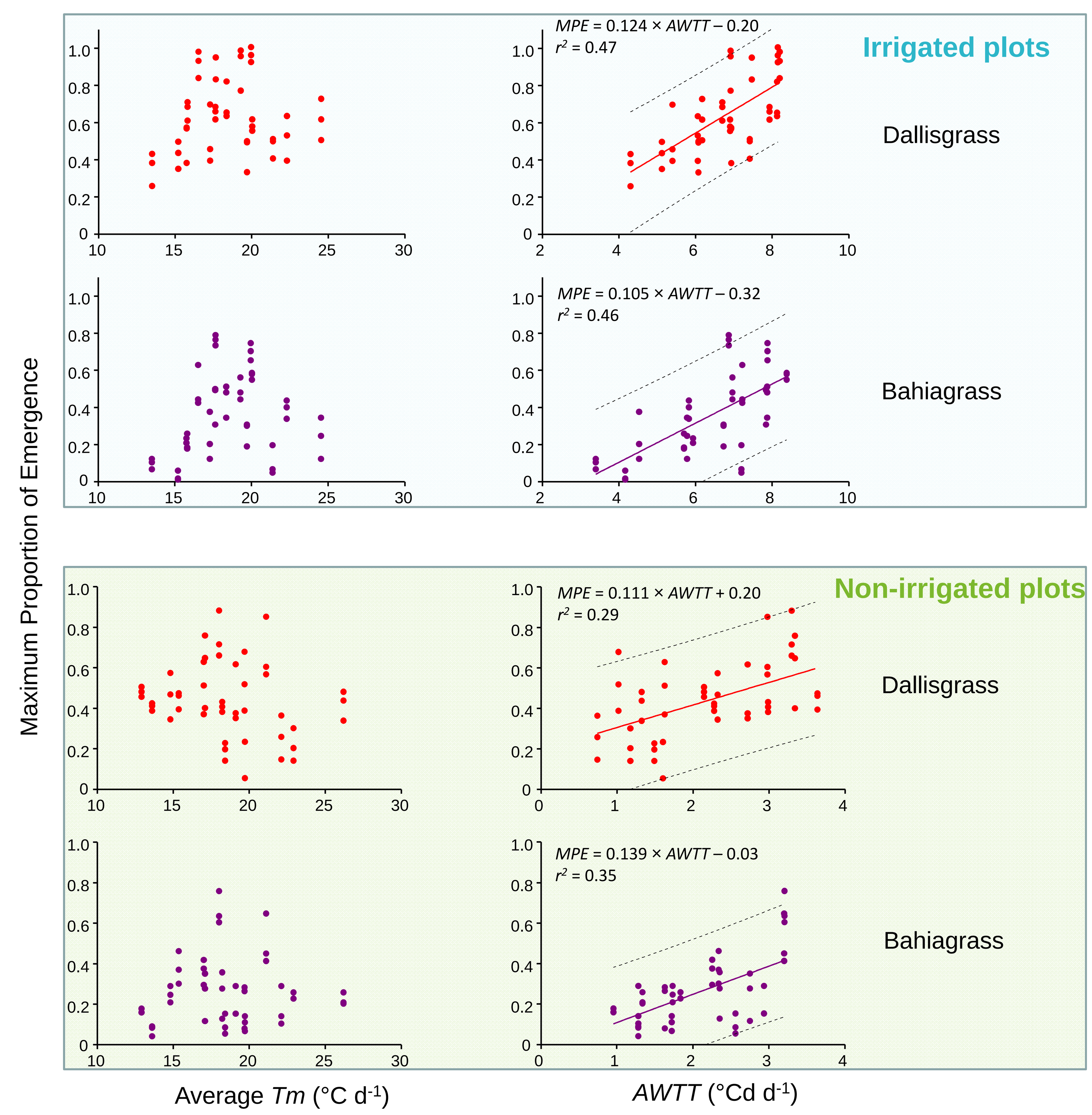

Figure 2. Maximum proportion of emergence (MPE) regressed on average mean temperature (left plots) and $AWTT$ (right plots) for each species and irrigation treatment.

DISCUSSION

Linear models for maximum proportion of emergence were achieved with the empirical variable $AWTT$. The resulting model may have no power of prediction, but the values adjusted could be informative for these species, that have not enough evidence on germination and seedling emergence.

Seed dormancy determines the extent of seedling emergence [4]. Reduced values of w_i could be interpreted as an increase in dormancy expression. When water potential is higher than Ψ_{low} and temperature is higher than T_{high}, low and even negative w_i values were obtained. This suggest a maintenance or an induction of seed dormancy under these conditions.

Althought each species adjusted the same values of w_i, there was a difference in temperature thresholds, where Bahiagrass showed higher thresholds than Dallisgrass. Bahiagrass may have higher optimum temperatures to germinate and emerge.

REFERENCES

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