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Seed production of endophyte-free and endophyte-infected tall fescue in response to partial submergence at two ontogenetic stages

Petigrosso, Lucas R.[1]; Vignolio, Osvaldo, R. [1]; Monterubbianesi, María G. [1]; Castaño, Jorge A. [1]; Gundel, Pedro E.[2,3]

[1]Facultad de Ciencias Agrarias, Universidad Nacional de Mar del Plata, Ruta 226 km 73,5, 7620 Balcarce, Argentina. [2]IFEVA, Universidad de Buenos Aires, CONICET, Facultad de Agronomía, Buenos Aires, Argentina. [3]Centro de Ecología Integrativa, Instituto de Ciencias Biológicas, Universidad de Talca, Talca, Chile. E-mail: lpetigrosso@mdp.edu.ar

Introduction

- Tall fescue, *Festuca arundinacea* Schreb., is a perennial C_3 forage widely used in most temperate regions of the world.
- This species occupies an important area in the Flooding Pampa Argentina (region comprising ≈9 million hectares) and it is commonly infected with asexual endophytes of the *Epichloë coenophiala* species.
- These endophytes enhance plant tolerance to biotic and abiotic stresses and produces alkaloids that are toxic to grazing animals.
- In the Flooding Pampa, the proportion of endophyte-infected plants is usually high – which suggests an endophyte-mediated advantage over the endophyte-free counterparts.

Objetive

- The objective of this work was to evaluate the endophyte effect on seed production of tall fescue plants subjected to partial submergence in two ontogenetic stages.

Materials and methods

- Seeds from four tall fescue materials were used: endophyte-free naturalized population (PE-) and -infected (PE+) with wild type *E. coenophiala*, and cv. Taita (Gentos S.A) endophyte-free (TE-) and -infected (TE+) with safe endophyte AR584 (Grasslanz Technology Limited, Palmerston North, New Zealand).
- The experiment was carried out in a glasshouse. Three seeds of the same tall fescue material were sown in 3 L plastic pots containing a mixed substrate (1:1 v:v) of river sand and topsoil from the horizon A of a Typical Argiudol and fertilized with urea and triple superphosphate to provide doses equivalent to ~50 kg N ha^{-1} and 20 kg P ha^{-1}. After 15 days, seedlings were thinned to leave one per pot.
- Both, at 5-leaf stage and at the beginning of the elongation of internodes, two submergence treatments were applied for 14 days: control (C, plants kept at field capacity) and partial submergence (PS, a 50 mm layer of water above ground level, Figure 1).
- At the internode elongation stage, half of the pots that had been subjected to each submergence treatment at the 5-leaf stage were assigned to the same previous treatment and the other half to the opposite treatment. After treatments, the plants were kept at field capacity until the reproductive phase was completed (Figure 1), to estimate seeds production.
- Results were analyzed with standard anova.

Results

- There was no significant interaction between the experimental factors.
- Plants subjected to partial submergence on 5-leaf stage showed less reproductive effort (22%) than those that remained at field capacity ($P< 0.001$, Table 1) that was irrespective of the plant material ($P=0.361$, Table 1).
- Partial submergence at the 5-leaf stage had a negative effect on panicles (Table 1, $P<0.001$) and seed production per plant ($P<0.001$, Table 1) that was regardless of the plant material and endophyte presence.
- On average, plants subjected to submergence at 5-leaf stage produced fewer seeds than those kept at field capacity (Table 1).
- No differences were recorded between plants subjected to partial submergence and plants maintained at field capacity in the 1000-seed weight (2.00±0.05 vs. 1.99±0.04) ($P=0.871$).

Figure 1. Pots placed in trays to ensure a water content close to field capacity through a 20 mm layer of water above ground level (A). Pots under partial submergence and field capacity with tall fescue plants at 5-leaf stage (B). Pots with tall fescue plants in vegetative (C-D) and reproductive states (E). Seed harvest (F).

Table 1. Reproductive effort, number of panicles and number of seeds per plant of four materials (M) of tall fescue: naturalized population with (PE+) and without wild endophyte (PE-) and cv. Taita with (TE+) and without safe endophyte AR584 (TE-); subjected to two water treatments (WT): control (C) and partial submergence (PS) at two developmental stages (5-leaf stage: Z15; beginning of the elongation of internodes: Z30-Z32). Equal lowercase letters in the same column and experimental factor indicate non significant differences (α=0.05). Values are means ± standard error (s.e.) of 10 replicates.

Experimental factor		Reproductive effort	Panicles	Seeds
M				
	PE+	0.258 a	8.97 b	1256.22 a
	PE-	0.292 a	10.73 ab	1453.17 a
	TE+	0.300 a	11.92 a	1431.57 a
	TE-	0.272 a	9.40 b	1293.51 a
	s.e.	0.020	0.70	93.00
WT Z15				
	PS	0.246 b	8.27 b	1080.18 b
	C	0.315 a	12.24 a	1636.06 a
	s.e.	0.012	0.46	65.80
WT Z30-Z32				
	PS	0.273 a	10.20 a	1412.86 a
	C	0.288 a	10.30 a	1303.37 a
	s.e.	0.014	0.52	65.80

Conclusion

- These results suggest that fungal endophytes would not confer a differential advantage to tall fescue plants under flooding conditions.
- Given that young plants showed high sensitivity to water excess, further studies should evaluate the effect of flooding on critical stages of seed germination and seedling emergence of endophyte-infected and endophyte-free materials.
- In addition, future research should explore how endophytes modulate host performance under water excess considering the co-occurrence with other stress factors (e.g., high temperatures).

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