# Alternate Hosts for Sugarcane Borer and Mexican Rice Borer

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# Stem borers in graminaceous crops
**(Lepidoptera: Crambidae)**

**Sugarcane borer**
***Diatraea saccharalis* (F.)**


**Mexican rice borer**
***Eoreuma loftini* (Dyar)**


***Reay-Jones et al. 2006, Way et al. 2006***

Two invasive crambids can be severe insect pests of graminaceous crops… such as corn, sorghum, sugarcane, or rice.

the SCB (occurs everywhere along the Gulf Coast)

the MRB (introduced into TX in the 1980s – now occurs in TX, was detected for the first time in LA in Dec 2008, and represents an imminent threat to the Louisiana rice and sugarcane industries

## Stem borer injury to rice (*Oryza sativa* L.)


*Way 2002*

Stem borer injury within the culm impacts grain development, causes whiteheads, and brakes mature culms

## Stem borer non-crop hosts

**"Virtually all grasses large enough to afford them shelter within the stem"**

**Family Poaceae**

- ***Echinochloa*** **grasses (e.g., barnyardgrass)**
- ***Leptochloa*** **grasses (e.g., sprangletop)**
- ***Panicum*** **grasses (e.g., fall panicum)**
- ***Paspalum*** **grasses (e.g., vaseygrass)**
- ***Sorghum*** **grasses (e.g., johnsongrass)**

*Bessin and Reagan 1990, Box 1951, 1956, Browning et al. 1989, Holloway et al. 1928, Johnson 1984, Jones and Bradley 1924, Osborn and Phillips 1946, Van Zwalunwenburg 1926*

Non-crops are found within and surrounding fields… and may enhance stem borer populations

## Role of non-crop grass hosts in agro-ecosystems

- **Previous studies in corn**

**- Grasses surrounding corn fields are substantial sources for spring *D. saccharalis* populations**

Jones and Bradley 1924

Is their contribution to stem borer populations in crop fields important?

# Role of non-crop grass hosts in agro-ecosystems

- **Previous studies in sugarcane**

**- In-field johnsongrass** [*Sorghum halepense* (L.) Persoon] **not associated with higher *D. saccharalis* infestations**

**- If cut 2 or 3 times a year, johnsongrass surrounding sugarcane fields does not host overwintering *D. saccharalis***

**Bynum et al. 1938, Ali et al. 1986**

# Role of non-crop grass hosts in agro-ecosystems

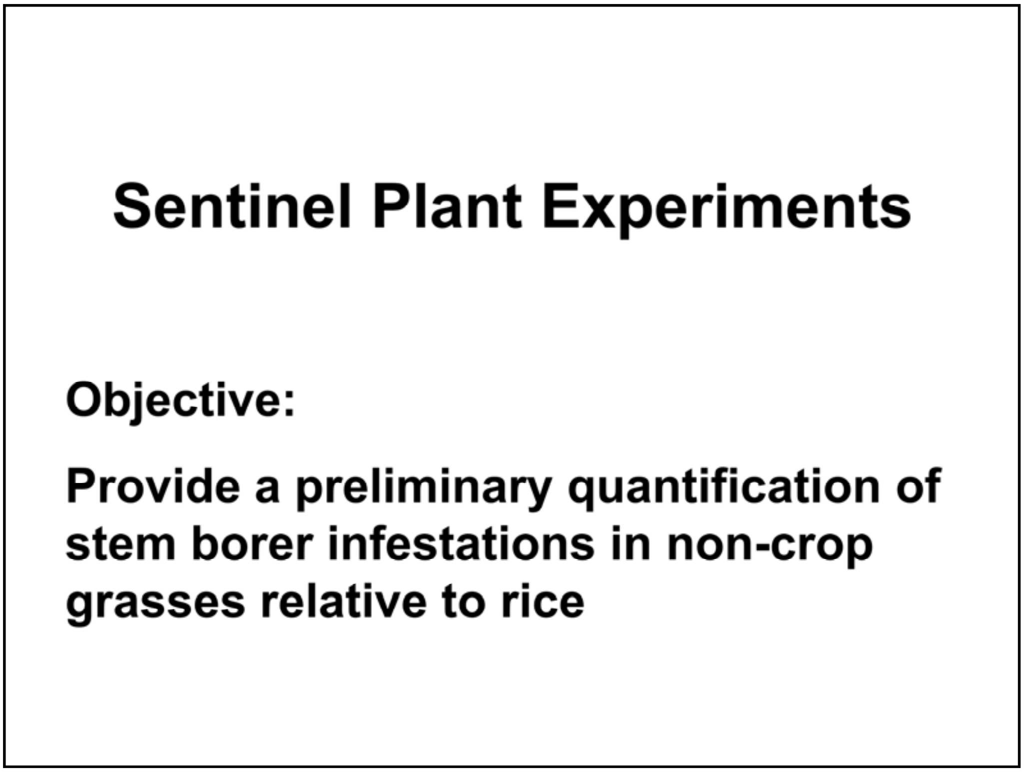
- **Previous studies in rice**

**- In-field sprangletop** [*Leptochloa panicoides* (Presl) Hitchc.] **associated with higher *D. saccharalis* injury**

**- *D. Saccharalis* breeds on various grasses surrounding fields before attacking rice**

**Bowling 1975, Tindall 2004**

Is their contribution to stem borer populations in crop fields important?




To confirm this hypothesis, we first conducted a sentinel plant experiment to provide a quantification of stem borer use of non-crop grasses compared to rice.

## Sentinel plant experiments

- **Summers of 2006 and 2007**
- **Five non-crop grass species:**
  - **Johnsongrass**, *Sorghum halepense* (L.) Persoon
  - **Vaseygrass**, *Paspalum urvillei* Steud.
  - **Amazon sprangletop**, *Leptochloa panicoides* (Presl) Hitchc.
  - **Broadleaf signalgrass**, *Urochloa platyphylla* (Munro ex C. Wright) R. D. Webster
  - **Barnyardgrass**, *Echinochloa crus-galli* (L.) P. Beauv.
- **Control:**
  - **Rice,** cultivar Cocodrie

***Beuzelin et al. 2010. Proc. Int. Soc. Sugar Cane Technol. (In Press)***

5 common grasses were used (JG and VG being perennial grasses, the other being annuals)

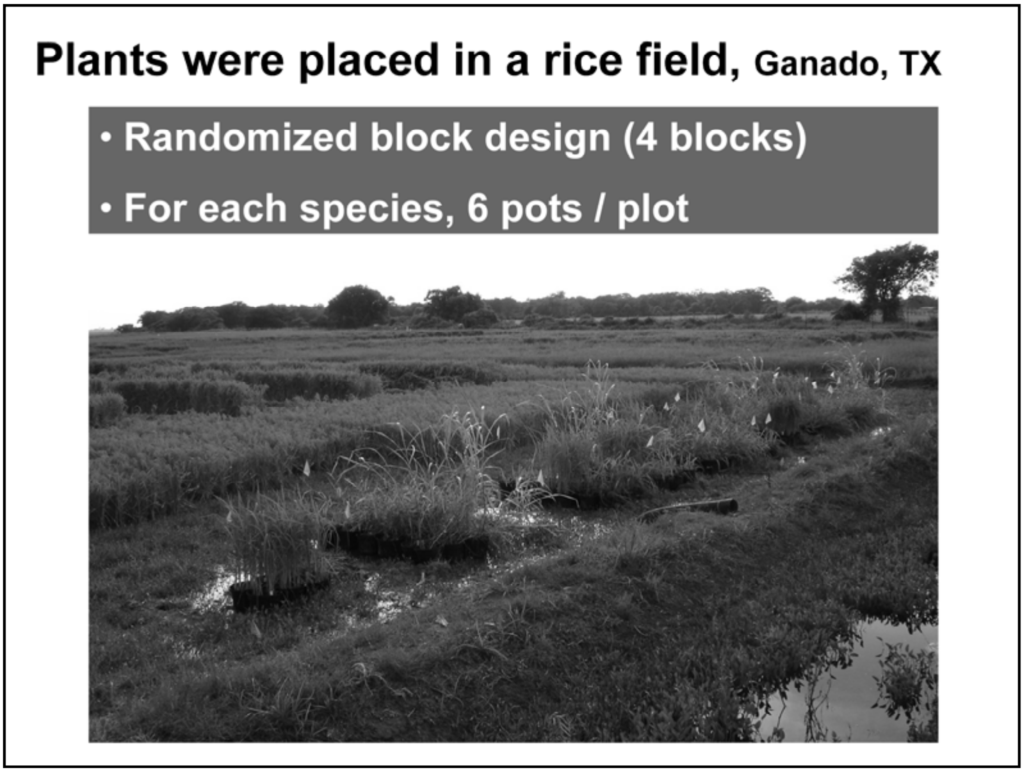
Rice cultivar Cocodrie served as a control

## Plants were grown in a greenhouse


Plants were grown in a greenhouse – 8 plants / pot

## Plants were grown in a greenhouse


And after 8 weeks -




They were placed close to a levee in a rice field as a RBD - with 4 blocks

In each blocks and for each of the 5 grass species and control , I made a plot of 6 pots

## Stem borer infestations were recorded


After 4 weeks in the fields, 10 plants for each plot were dissected, and borer infestations were recorded

## Stem borer infestations after 4 weeks (2006)

| | No. stem borer / plant[a] | % *E. loftini* vs *D. saccharalis*[b] |
|---|---|---|
| A. sprangletop | | |
| Rice | | |
| Johnsongrass | | |
| Broadleaf signal grass | | |
| Barnyardgrass | | |
| Vaseygrass | | |
| *F* | | |
| *Pr > F* | | |

**SAS, Proc Glimmix, [a]Poisson distribution or [b]Binomial distribution - Tukey's HSD, α = 0.05**
**Means within a column with the same letters are not significantly different**

Stem borer infestations attained an average of more than 2 borers/plant in sprangletop. Then, range from 1 borer/plant in rice to 0.1 in vaseygrass.

The proportion of MRB vs. SCB did not differe with the host, being on average close to 50/50.

# Discussion – Sentinel plant experiments

- ***E. loftini*** **and** ***D. saccharalis*** **infest non-crop grasses**
  - **Infestation levels <, >, or ≈ those in rice**
    *Preliminary quantification*
  - **Plants with smaller stem diameter did not allow completion of the life cycle**
    *Physical constraint?*

**Grasses have the potential to sustain and build-up stem borer populations**

## Weedy Habitat Surveys

**Objective:**

**Provide seasonal estimates of stem borer use of non-crop hosts in the Texas rice agroecosystem**

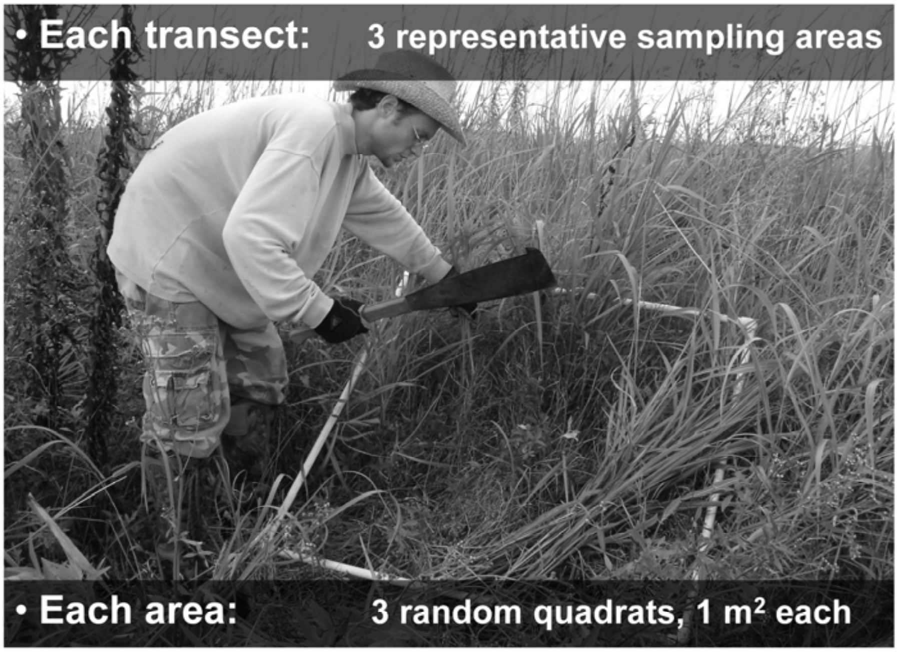
## Weedy habitat surveys, southeast TX

- April, 2007 to February, 2009
- 3 farms - upper, medium, lower TX rice area

# Weedy habitat surveys, southeast TX

• Each farm: 2 transects through non-crop habitats (field margins, ditches, roadsides)

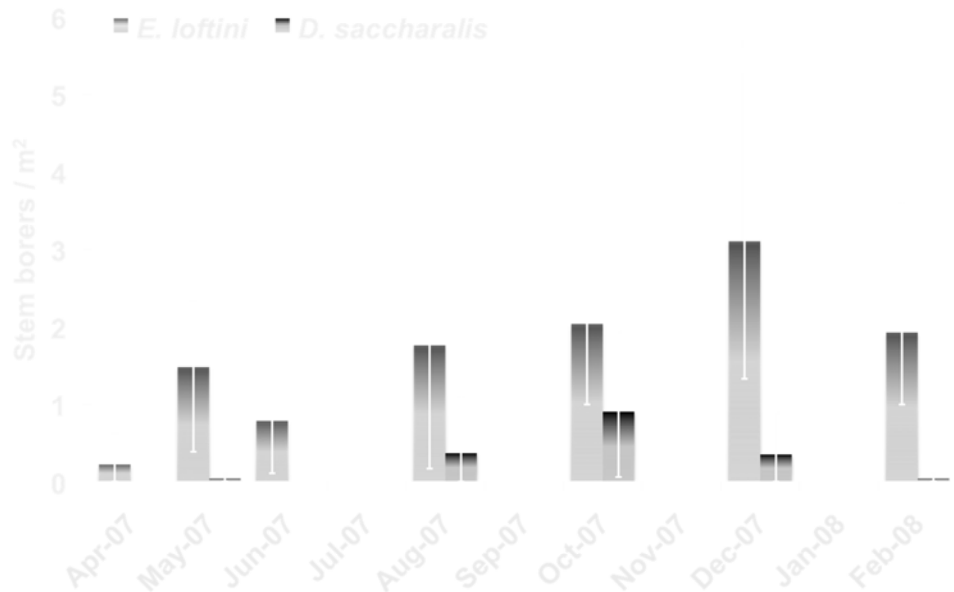
## Weedy habitat surveys, southeast TX



# Weedy habitat surveys, southeast TX

- Samples from each quadrat were processed

## Stem borer densities in non-crop habitats (2007-2008)




Overall average density – minimum and maximumdensity

# Non-crop grasses host stem borers in rice agroecosystems

- **Seasonal sampling over two years:**

**- Early annual grasses infested during the spring**
**Brome,** *Bromus* spp.
**Canarygrass,** *Phalaris* spp.
**Ryegrass,** *Lolium* spp.

**- Perennial grasses infested throughout the year**
**Johnsongrass,** *Sorghum halepense*
**Vaseygrass,** *Paspalum urvillei*

***Beuzelin et al., unpublished data***

# Greenhouse Experiment

**Objective:**

**Provide estimates of *E. loftini* oviposition preference and larval performance on primary non-crop hosts**

# Oviposition preference, larval performance

- **Summer of 2009, Beaumont, TX**

- **Four non-crop grass species:**

  - **Brome,** *Bromus* spp.
  - **Ryegrass**, *Lolium* spp.

  @ two stages
  6 and 10 wks after planting

  - **Johnsongrass**, *S. halepense*
  - **Vaseygrass**, *P. urvillei*

  **6, 10 & 14 wks after planting**
  **@ three stages**
  **7, 12 & 17 wks after planting**

- **Crop grass:**

  - **Rice,** cultivar Cocodrie

  @ three stages
  5, 9 & 13 wks after planting

## Plants were grown in a greenhouse


Plants planted on different dates to achieve desired phenology at the same time

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Plants planted on different dates to achieve desired phenology at the same time

# Plants characteristics were recorded

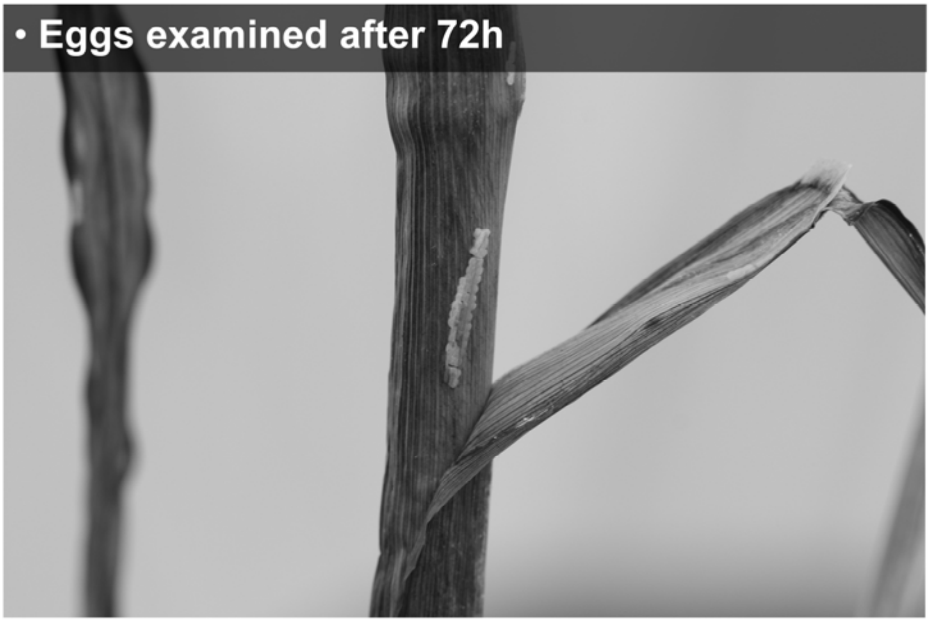
- Plant measurements
  - No. shoots
  - No. leaves (green and dry)
  - Size
- Separate plant samples
  - Fresh weights estimated from 5 plants per grass* stage combination
  - Additional samples stored at -80°C for future bio-chemical analyses

## Adult *E. Loftini* were released in the cages

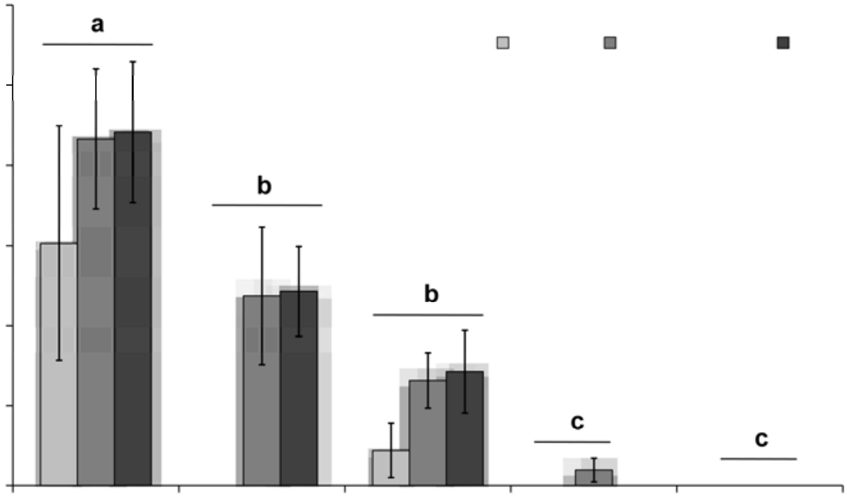
- *E. loftini* colony
  - < 3 month-old colony
  - Maintained in Weslaco, TX
- Mating upon adult emergence
  - 10 females and 5-10 males in container for 24h
- Release
  - 10 females and 5-10 males in each cage for 72h

# Oviposition assessment

- Eggs examined after 72h

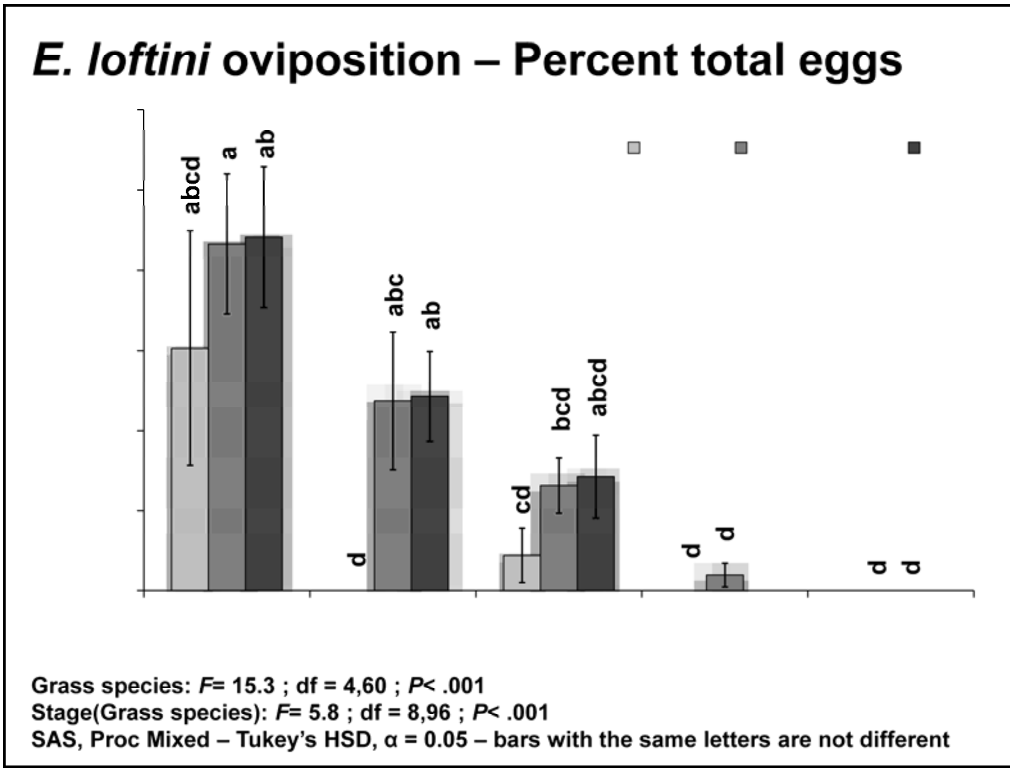


## *E. loftini* oviposition – Percent total eggs




**Grass species: *F*= 15.3 ; df = 4,60 ; *P*< .001**
**Stage(Grass species): *F*= 5.8 ; df = 8,96 ; *P*< .001**
**SAS, Proc Mixed – Tukey's HSD, α = 0.05 – bars with the same letters are not different**

420 eggs / cages, virtually nothing on mesh cloth




420 eggs / cages, virtually nothing on mesh cloth

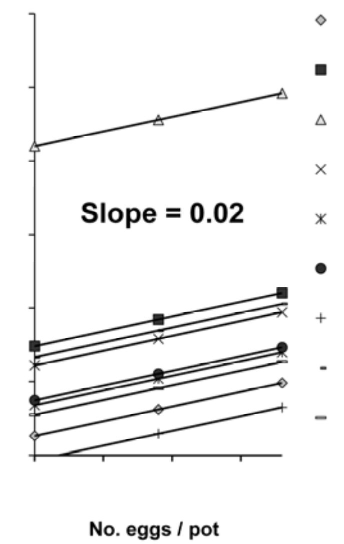
# Larval performance assessment

- Plant dissection after 480 ± 9 (SE) °D
- Number and weight of immatures were recorded

- Larvae reared on artificial diet
- Pupae kept until adult emergence
  → °D to adulthood determined

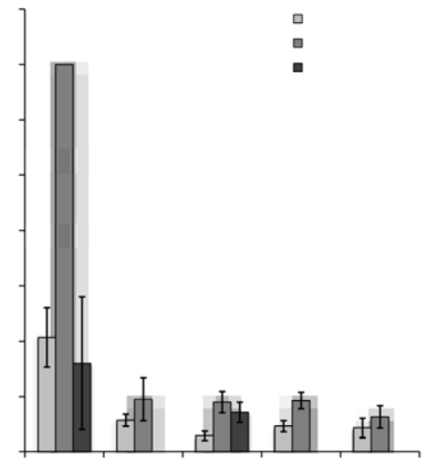
# *E. loftini* performance – No. immatures

- **Presence of eggs**



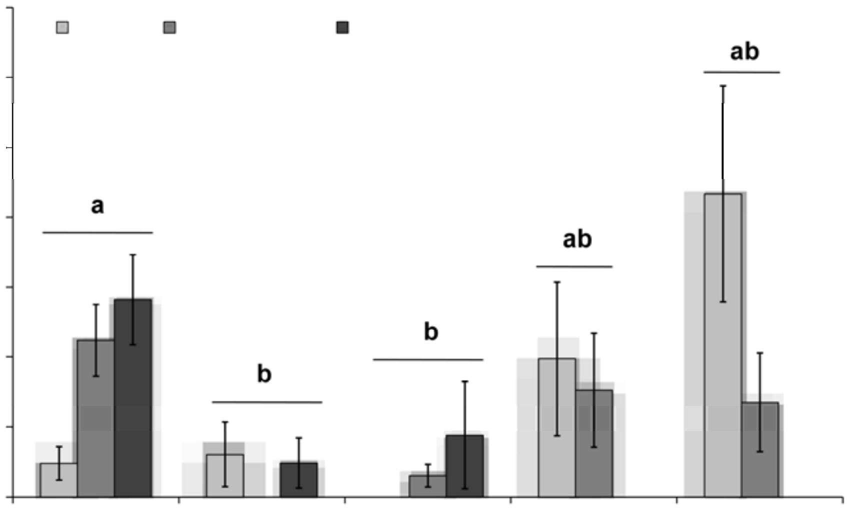

**SAS, Proc Mixed – ANCOVA,** Grass species: $P < .001$
Stage(Grass species): $P < .001$ , Eggs: $P < .001$

- **No eggs**



**SAS, Proc Mixed – ANOVA,** Grass species: $P < .001$
Stage(Grass species): $P < .001$

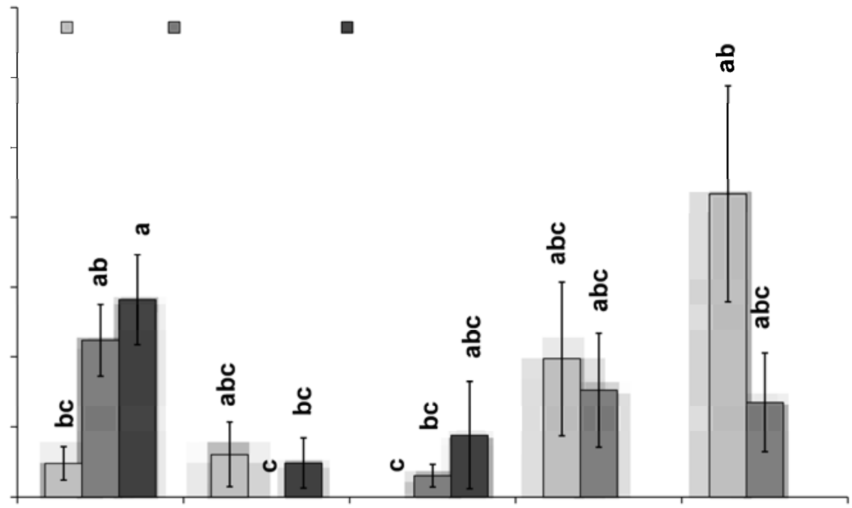
## *E. loftini* performance – Proportion of pupae




**Grass species:** ***F*= 6.1 ; df = 4,59 ; *P*< .001**
**Stage(Grass species):** ***F*= 3.8 ; df = 8,79 ; *P*< .001**
**SAS, Proc Mixed – Tukey's HSD, α = 0.05 – bars with the same letters are not different**

DD range from 419 to 536.

## *E. loftini* performance – Proportion of pupae

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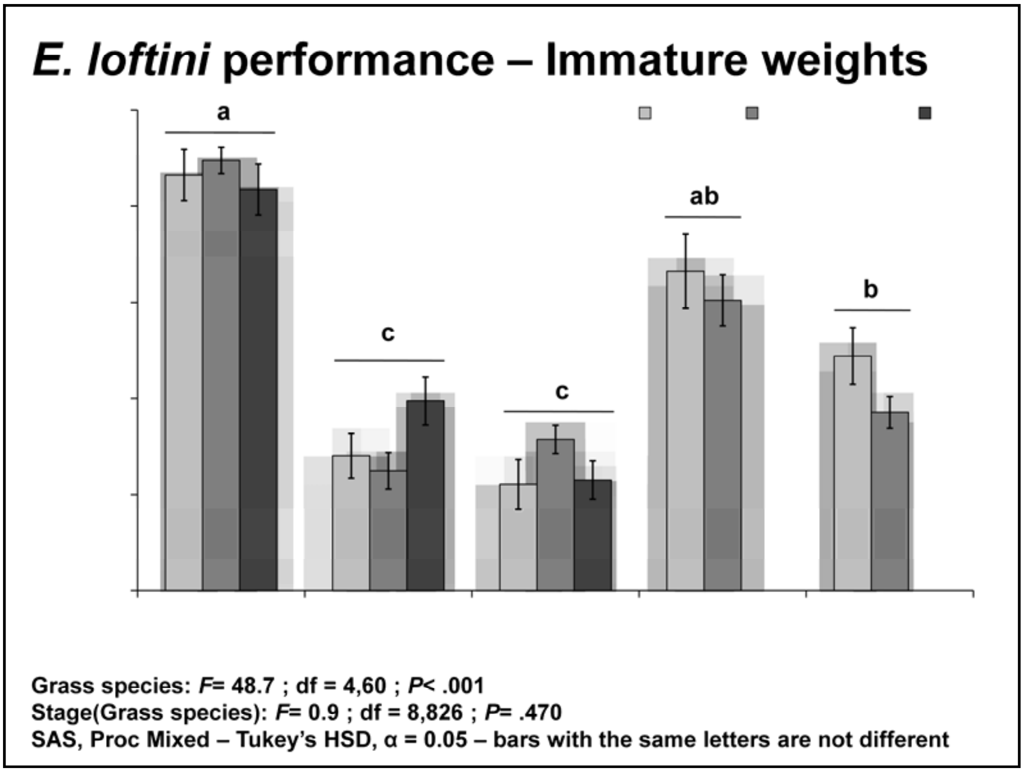


DD range from 419 to 536.

# Discussion – *E. loftini* preference and performance

- Rice: preferred and very suitable
- Perennials: less preferred and less suitable
- Early annuals: not preferred but suitable

- Plant characteristics involved
  - Dry leaf material
  - Size, no. shoots, shoot diameter
  - Plant metabolites

*Reay-Jones et al. 2007*

# Discussion – *E. loftini* adult oviposition preference

- **Derive preference coefficients**

$$\hat{\alpha}_i = \frac{n_i}{\max n}$$

$n_i$ : number of eggs laid on the i$^{th}$ host

max $n$ : max. number of eggs laid on one host across different available hosts

- **Predict host selection**

$$\hat{n}_i = n_{total} \frac{\hat{\alpha}_i A_i}{\sum_{i=1}^{i} \hat{\alpha}_i A_i}$$

$n_{total}$ : total number of eggs

$\hat{\alpha}_i$ : preference coefficient for the i$^{th}$ host

$A_i$ : i$^{th}$ host relative availability

*Reay-Jones et al. 2007*

# Discussion – *E. loftini* larval performance

- Compare development on artificial diet vs. different host plants


$$\alpha_{ij} = \frac{A_{ij}}{A_{dj}}$$

$\alpha_{ij}$ : empirical ratio
$A_{ij}$ : age in °D to $j^{th}$ stage on $i^{th}$ host
$A_{dj}$ : age in °D to $j^{th}$ stage on artificial diet

- Predict development on different hosts

## Conclusion – A new perspective for *E. loftini* management

- Integrate previous studies on *E. loftini*:
  - Preference and development on crops
  - Seasonal infestations in non-crop habitats

- Perform theoretical analyses to forecast *E. loftini* population dynamics under different non-crop host management scenarios

- Answer the question:
  "Will non-crop host management decrease *E. loftini* infestations?"

## Acknowledgments

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# Questions?

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