Evaluation of sorghum lines and hybrids for cold tolerance under field and controlled environments

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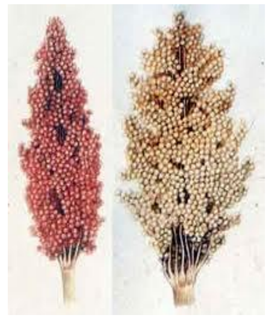


Introduction

Sorghum is vulnerable to freezing temperatures and suffers chilling injury when subjected to non-freezing temperatures below 50˚ F. Low temperature stresses during germination and early vegetative growth results in poor seedling establishment (Fig) and reduced growth rate after emergence (Yu et al., 2004).Therefore, development of cold tolerant sorghum lines is a priority, which will be beneficial for sorghum cultivation in Kansas and its extension into northern regions of the United States. Cold tolerant sorghum hybrids can be used to take advantage of early season moisture, minimum tillage and a longer growing period. Adapted, cold-tolerant sorghum hybrids will increase competitiveness of sorghum in semi-arid cropping systems.

Materials and Methods

Experiment 1: Field Study -2011 (Fig)

- Genotypes 48 (28 promising lines from Hays, KS, 6 RILs from the cross Tx430 x SQR, 4 Chinese - SQR, Gai Gaoliang, Hong Ke Zi and LiangTangAiR, 6 hybrids involving Redbine 58A and 4 hybrid checks (Pioneer 8500, 86G32 and 85G03, Sorghum Partners NK7633).
- Locations = 2 (Hays & Colby, KS);
- Planting dates = 2 Early planting (2 May 2011) & regular planting (31 May 2011); Design = RCBD with 3 replications.
- Traits measured: Emergence %, Emergence index (EI), seedling height, number of leaves, Shoot biomass (30 day after emergence), days to flowering, Panicle exertion and length, Plant height.

Experiment 2: *Pythium* spp. Screening

- Genotypes 48 screened against *Pythium aphanidermatum* and *P. irregulare*.
- Isolates obtained from soils collected from sorghum fields in Manhattan, KS using a soil baiting technique. (Frank, 1972).
- Inoculations were performed using a "layer cake" (1:1:1 soil:sand:promix) & ten evenly spaced sorghum seeds (fourth layer),
- Temperature regime: 25/16˚ C day/night for 12h.
- Traits measured: cumulative EI (CEI); Seedling fresh weight.

Experiment 3: Seed quality analysis

- Genotypes 48
- Physical grain traits (kernel hardness, diameter, and weight - measured using the single kernel characterization system (SKCS) as described by Bean et al., (2006);
- Total phenolic concentration as described by Singleton et al. (1965);
- Tannin content was determined using the vanillin hydrochloric acid method and reported as catechin equivalents (CE) in mg/g of sample (Price et al 1978)

Experiment 4: Controlled environments study (Fig)

***4.1 Emergence Index study*:**

- 18 selected Lines from experiment 1 based on EI and 30 day biomass comprising 3 categories (Low EI/Low biomass; Low EI/medium biomass; High EI/High biomass)
- Planted in Sand filled tubs using RCBD with 3 reps and grown in growth chamber and cold table (Fig 1).
- Temp.: 15/12 ºC day/night at 12h cycle.
- Traits measured: Emergence %, EI.

4.2 Seedling biomass study:

- 18 lines studied in Petri dishes under dark condition for 24h at 22˚ C in an incubator.
- Potting mix: soil (Harney silt loam) and vermiculite (1:1).
- Design = RCBD with four replications on two planting dates (15 Nov and 05 Dec 2011)
- Location: Two greenhouses (Hays, KS, and Colby, KS).
- Greenhouse temperature: 12.7˚ C and ventilated when exceeded to 18.3˚ C.
- Seedlings were transplanted to cone-tainers (38/203 mm diameter/deep)
- Traits - Emergence % (E%) Emergence Index (EI); Formulae Used (Fakorede and Ayoola, 1980

Objectives

To evaluate the elite and advanced breeding lines, RILs and hybrids for early season cold tolerance under field conditions,

To identify potential breeding lines tolerance to cold and *Pythium* spp. infection with desirable seed quality traits for hybrid testing.

To evaluate the selected lines under controlled environments and in comparison with field performance, optimize high throughput early screening procedure to evaluate large breeding materials for cold tolerance.

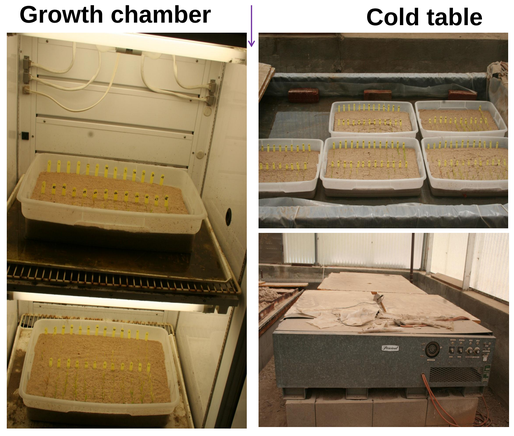
Expt. 1: Field study

Healthy line Line showing cold stress symptom

Expt. 4: Controlled environments study

Sand filled tubs & Seed planting

Growth chamber Cold table



Seedling germination

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Results and Summary

- Significant differences among the genotypes were recorded for all the seedling (emergence percentage, emergence index (EI), shoot biomass, plant height and leaf number measured 30 days after emergence), agronomic (days to 50% flowering, panicle exertion, panicle length and plant height at maturity) and seed quality (kernel hardiness, kernel weight, kernel diameter, total phenolic and tannin content) traits.

- Location, planting date and their interaction with genotype had highly significant effect on emergence index indicating their influence in 100% emergence of the sorghum plants

- Eight advanced breeding lines (PI574578R/3/KS118B-3, PI574586R/4/KS119B-2, PI574578R/3/KS118B-4, PI574578R/3/KS118B-2, PI574570R/4/KS120B, pollenCompT4C4-210R/PI574554R-5, PollenCompT4C4-210R/PI574554R-3, TX430/SQR-2 and PI574599R/B35-6B) were selected based on seedling (EI and biomass) and seed quality traits including low phenolic with no tannin content.

- Of these, PI574578R/3/KS118B-3, PI574586R/4/KS119B-2 and PI574570R/4/KS120B-2 showed tolerance to *Pythium* spp. infection.

- Significant correlation was observed between EI and biomass in both locations in early planting suggesting that late emergence produces greater biomass compared to early emergence.

- Results from the selected 18 lines from the controlled environments studies indicated significant correlation between growth chamber and field study for EI and shoot biomass suggesting that the growth chamber is more reliable for large breeding populations preliminary cold tolerance screening.

- Potting mixture study concluded that soil+vermiculate mix was more effective for controlled environment cold tolerance screening against soil+sand and soil+peat potting mixes.

- Selected breeding lines are being used in test hybrid evaluation to assess fertility status, combining ability and yield performance.

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Acknowledgments

We thank the Kansas Grain Sorghum Commission & United Sorghum Checkoff Program for continuous funding support.