Phenotyping sorghum reference set for post-flowering drought tolerance – Year 1 Progress

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Rationale and background information

- Sorghum - the world's fifth most important cereals
- Grown throughout the arid and semi-arid tropics
- Drought - a major constraint to production globally
- Post-flowering drought stress results significant yield loss
- Stay-green trait associated with post-flowering drought stress
- Stay-green QTL introgression lines (QTL-IL) in R 16 and S 35 background developed

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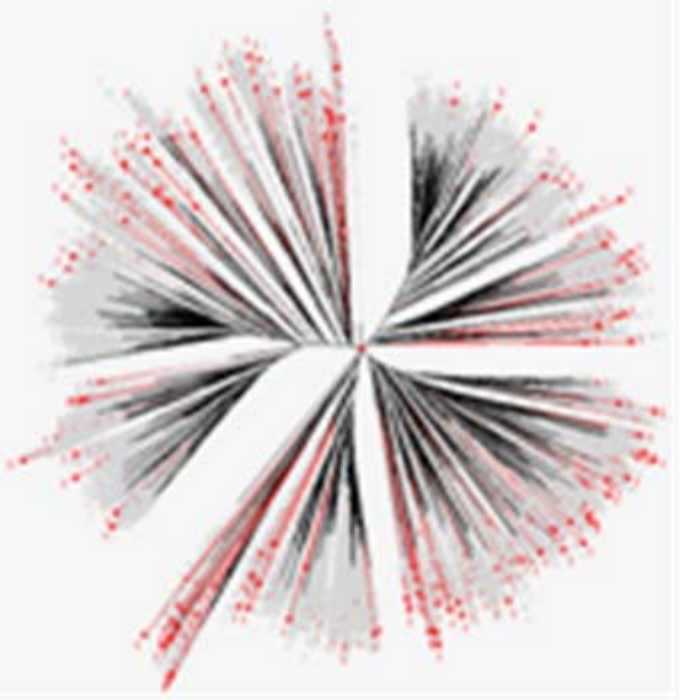
Rationale and background information

- Using world collection of sorghum, a composite collection (3367 accessions) developed molecularly profiled, and a reference set proposed (384 accessions), representing 78% (615 of the 789 alleles) of the SSR marker allelic diversity of the composite collection
- All races, regions and countries with substantial sorghum production within region represented in reference set



Activities 2008/09 crop seasons

Location	Activity
Patancheru, India	Reference set field evaluated for post-flowering drought tolerance Reference set & stay-green QTL-IL evaluated for water extraction (WE) & transpiration efficiency (TE) Reference set evaluated for seed micronutrient (Fe & Zn)
Samanko, Mali	Reference set field evaluated for post-flowering drought tolerance
Kiboko, Kenya	Reference set accessed for phenological differences to evaluate for post-flowering drought tolerance
Dharwad, India	Reference set accessed for phenological differences to evaluate for post-flowering drought tolerance at Dharwad and Bijapur

Methodology

- Accessions grouped to similar phenology to impose stress
- Field evaluated accessions with similar flowering in split-plot design under drought stress (DS) and non-stressed (NS)
- Used % change in grain yield between DS and NS to measure response to drought
- Accessions either with least difference in response to DS or higher seed yield under DS identified as drought tolerant

- Lysimetric system used to measure WE & TE under partially controlled environment
- Rate of leaf senescence used to measure stay-green trait

Result from field grown experiment

- Significant moisture (M), genotype (G) and MxG interaction
- 54 accessions yielded at par or least affected (<10% yield reduction) by DS
- 45 accessions produced >20% more grains under DS than NS conditions
- Guinea-kafir race accessions least affected (27% yield reduction under DS) while those from kafir-bicolor race highly affected (79% yield reduction under DS)

Variation for stay-green trait in reference set

- Few accessions retained their stay-green trait while many accessions completely dried up under DS conditions
- SCMR I (at flowering) and SCMR II (at 30 DAIDS) positively correlated under NS (0.626, $P<0.01$) and DS (0.363, $P<0.01$) conditions
- Stay-green trait differed significantly among entries while chlorphyll content not stable over time & not correlated with rate of leaf senescence

IS 2367

Non-stressed

Drought-stressed

IS 24009

Non-stressed

Drought-stressed

Variation for WE and TE in reference set accessions using Lysimetric system

- WE ranged from 10.2 kg plant^{-1} to 15.3 kg plant^{-1}, while TE from 2.44 g kg^{-1} to 6.09 g kg^{-1} water transpired
- Several accessions showed higher WE and/or TE than stay-green QTL lines, R16 and S35
- Higher TE in a number of QTL-IL in R16 background under DS than under NS conditions

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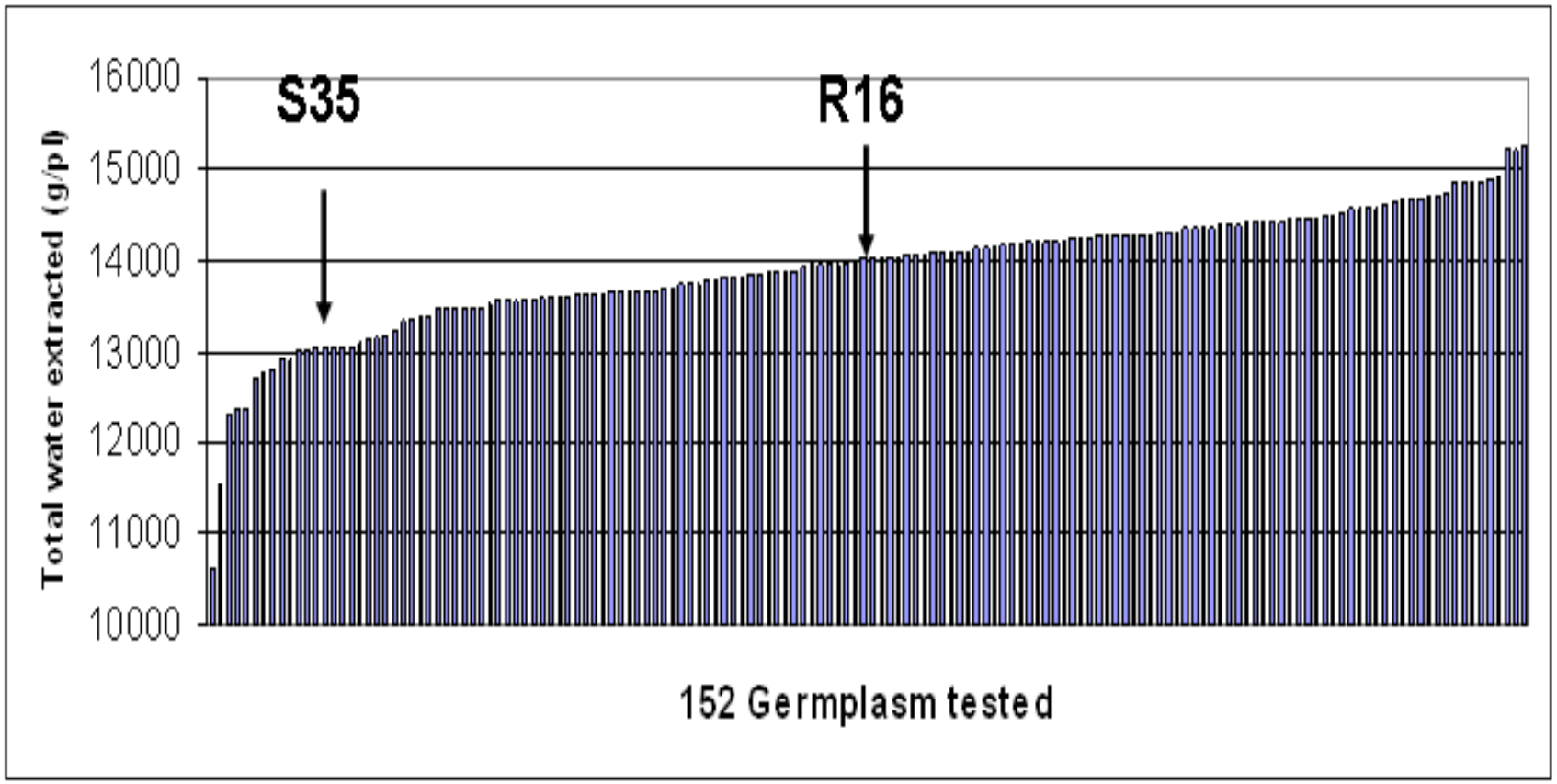
Variation in WE among reference set accessions under DS conditions



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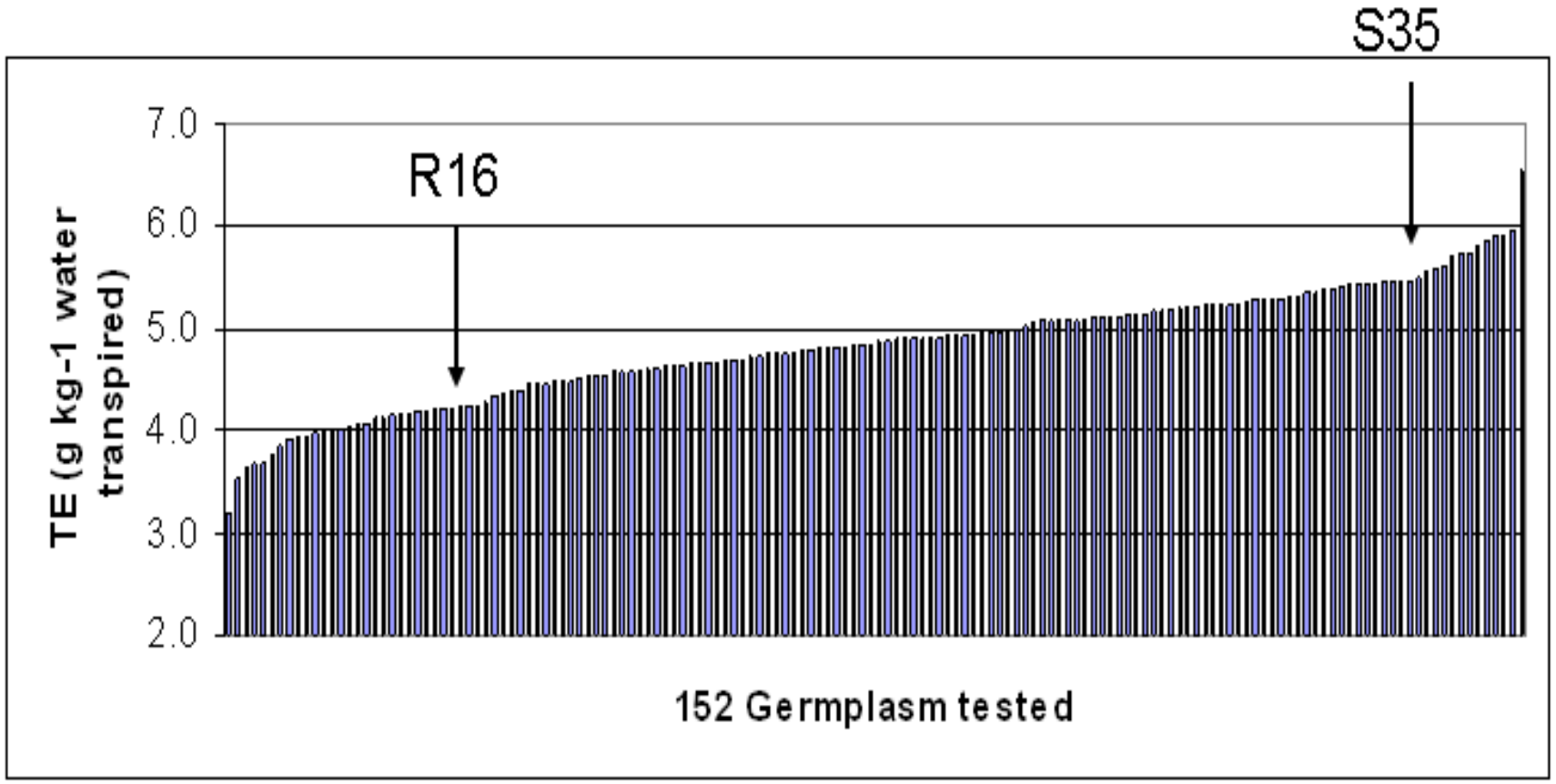
Variation in TE among reference set accessions under DS conditions



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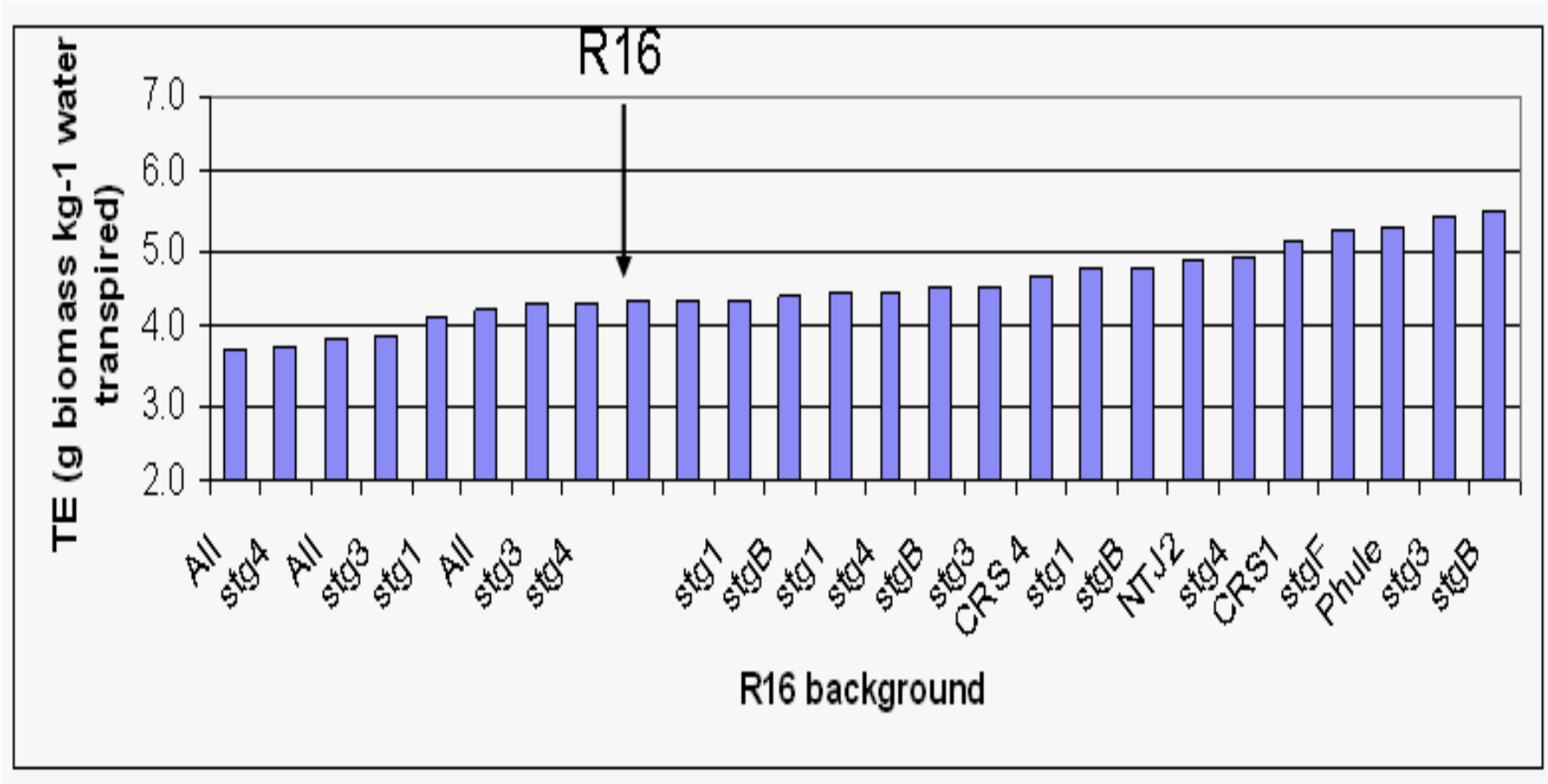
Variation in TE among QTL-IL under DS conditions



Data format/release and link with other GCP projects

Data format & release:

- Data will be made available in EXCEL to GCP website after completion of the project

Linkage with Other GCP Projects:

- Drought tolerance improvement for sorghum in Africa (CI)
- MAGIC population development in sorghum

Product delivery and impact on users

- Lysimetric system standardized to screen for WE and TE in sorghum
- Several accessions and QTL-IL with high WE and/or TE ability identified
- Several accessions produced more grain yield under DS conditions
- Many accessions expressed stay-green trait
- Large range of variation in WE, TE and rate of leaf senescence

Sorghum MAGIC status:

Challenges: Sorghum is proving more difficult in than anticipated – pearl millet would have been easier!

- Time:

  Attempting 3 generations per year, but 2 generations appear more likely to be achieved as many candidate parents have inherently long juvenile growth phases

  – Aggravated by extreme variation of candidate parents for base flowering time & photoperiod sensitivity
    - Taking more time than planned to complete all required crosses each generation

- Numbers of crosses:

  Reduced 8-parent populations still need very large numbers of 4-way crosses (70 combinations per population)

  – Need to genotype very large numbers of plants (additional DNA isolation & marker data costs), especially when making >1 cross per combination to ensure crossing success

Thank You