Sorghum production quality in SAT; biology & technology

G×E×M×S team

System Analysis for Climate Smart Agriculture Theme

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(+ILRI, QUAAFI, IIMR, Fraunhofer, HarvestMaster)

Sorghum_21st century_2018
How to enhance SAT systems production?

Turning complexity into opportunity!!!
Rabi sorghum usage, SAT;

Livestock per capita

Dual purpose; stover/grain

Livestock feed

Sorghum bread

Current breeding product profile

<table>
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<tr>
<th>Product concept</th>
<th>Resistance/tolerance required</th>
<th>Other criteria</th>
<th>Product development goals</th>
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<tr>
<td>Post-rainy season sorghum for food and feed</td>
<td>Shoot fly, aphid and charcoal rot resistance; Post-flowering drought tolerance</td>
<td>Plant height: 2.0 to 2.2 m; Must have traits: White, globular, bold, lustrous grains; high biomass; high stover quality</td>
<td>5% increase in grain yield and 10% increase in stover yield over best check (M 35-1; Parbhani Moti, Phule Vasudah, Phule Revti)</td>
</tr>
</tbody>
</table>

Grain/stover qualities restrain cvs. adoption?
Maldandi (M35-1)

Environment of cultivation reversed acceptability of products!
Overview:

1. Plant functions linked to WU; 
   .........yield quantity in SAT

2. Plant functions linked to WU; 
   .........yield quality in SAT?

3. Tools necessary to accelerate research on grain qualities
Plant functions linked to WU=> STG => yield QUANTITY (see V.Vadez ppt)

Traits with high heritability, genetically and functionally correlated to yield in TPE

Grain Yield

Grain Number

Grain Size & N

Δ Biomass

TE

T

RUE

R_{int}

 radicals

kl

Root

SLN

k

LAI

N

LNoT

Hammer et al.

APSIM Generic Crop Template

WU-related traits

“drought tolerance”

R² = 0.7108

Grain Yield (g plant^{-1})

WU in week 3 after panicle emergence

0.0 1.0 2.0 3.0 4.0

0 4 8 12 16 20

0

Vadez et al. 2011

Murugesan et al. 2017

DO NOT COPY
Crop WU => STG

CANOPY
growth & conductivity
underlie stay-green ILs
Plant WU => STG => yield QUALITY

STG_QTLs alter stover quality

Blümmel and Parthasarathy, 2006

Blümmel et al., 2015

STG_QTLs affect grain qualities

WHAT are the functional processes & its genetics?

(Chandalavada et al., in prep)
WHAT are the functional processes & its genetics?

(Chandalavada et al., in prep)

\[ y = -0.0314x + 4.497 \]
\[ R^2 = 0.6374 \]

\[ y = 1.6134x + 4.4771 \]
\[ R^2 = 0.5819 \]

\[ y = 0.1883x + 0.5242 \]
\[ R^2 = 0.4126 \]

\[ \Delta \text{ Plant WU} \]
\[ \Delta \text{ senescence} \]
\[ \Delta \text{ TE, photosynthesis} \]
\[ \Delta \text{ grain qualities} \]

=> genetic background dependency!

Senescence [%] => STG => WU

\[ \text{grain size [g/100]} \]

\[ \text{grain size [g/100]} \]

\[ \text{grain AA [w/w%]} \]

\[ \text{Stem/stover ratio} \]

\[ \text{grain AA [w/w%]} \]
WHAT are the functional processes & its genetics?

=> Independent RIL populations with $\Delta$ grain size; N13 x E36-1.

50% variability

Grain size QTL co-localize with early vigor QTLs on chromosome 5
How to process so many samples?  XRF+NIRS; calibration curves

XRF prediction

R² = 0.89

Zn content [ICP-MS]

NIRS prediction (%)

y = 0.9653x + 0.3761
R² = 0.9563

Wet- LAB(%) [Kjeldahl]

Protein

Multi-cereals protein

y = 0.9159x + 0.8962
R² = 0.933

NIRS prediction (%)

Wet- LAB(%) [Kjeldahl]
Sample-processing...in the field???

=> Adapt existing equipment for new usage
=> Physically combine pieces

Processing quality
Grain size, moisture, Bulk density...

Product definition
Protein, Starch, Oil, AA....

Value for human health
Fe, Zn, Ca, As, Cd ...

=> Part of CG-EiB effort, multi-crop
Conclusion:

1. Plant functions linked to WU affect yield quantity and quality

2. More research needed to dissect causal mechanisms affecting quality...

3. Breeding & research on crop qualities require reliable HTP tools!!!
Thank you
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Mission
To reduce poverty, hunger, malnutrition and environmental degradation in the dryland tropics