Identifying avenues for increases in HI whilst maintaining post-anthesis photosynthetic capacity in wheat

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CENEB, Ciudad Obregon
Represents an actual set of elite material breeders would realistically use in their strategic crosses aiming to further raising yield potential.

- Older cultivars which represent landmarks in past genetic gains
- High-yielding elite cultivars
- Synthetic derived wheat material
- Lines derived from the most recent CIMMYT selection since 2000
Grain yield genetic gains associated to? Is sink size being increased optimally?

Year of release, 8 historic CIMMYT spring wheat cultivars
Similar results: Khaled et al, 2015 (12 historical CIMMYT cultivars).
Trade-off between biomass and HI

- Non-linear association between grain yield and HI
- Trade-off between biomass at harvest and harvest index
- Similar trends in HiBAP

Raised beds, 26 CIMCOG cultivars, 2011-2013
Suggestions for maximizing grain number and HI

**Anthesis**
- Spike ~ 25% (+7%)
- Leaf lamina ~ 20%
- Leaf sheath ~ 15%
- True stem ~ 40%
  - Lower SW/length of int 2/3
  - Increased spike WSC
  - No changes in stem WSC

**Harvest**
- 140 grains/g spike
  - Reduce specific rachis weight
- 75-85 cm tall & stronger stem bases
- HI ~ 0.6
  - Reduce structural stem DM
  - Reduce chaff
  - Maintain LS
  - Increase spike WSC pre-anthesis

**Fruiting efficiency**

Foulkes et al., 2011 and Rivera-Amado, et al., 2015
Objectives

• To quantify source-sink balance in the CIMCOG panel during grain filling.

• To estimate the extent of contribution of photosynthesis during grain filling from the lamina and/or leaf sheath to final grain growth.

• To investigate spike photosynthesis up-regulation in response to source manipulation treatments.
Field experiments

- Yaqui Valley
- 2011 to 2014 (Nov-Apr)
- Yield potential conditions
- 26 elite spring wheat cultivars
- Lattice field experiment design
- 2 subsets chosen for source manipulation treatments
Post-anthesis source and sink concepts

**Sink** = Storage capacity of the grains (PWG)

**Source** = Current photosynthetic capacity and assimilate stored to fill the grains (+10% inc. GW)

**Co-limitation** = limitation by sink and source (first and second half of grain fill)

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**De-graining treatments**

Yield limited by source

Yield limited sink

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**Def/LS cov treatments**

Give an estimation of the contribution of the organ to final GW
Source-sink manipulation treatments

- De-graining: 2011-2013 (26 cvs)
- Defoliation: 2012 and 2013 (10 cvs)
- LS covering: 2014 (4 cvs)

2 m length
4 rows
12 shoots/treatment
Source-sink manipulation treatments

Grain weight and number responses (%) to all treatments

Spike and flag leaf photosynthesis up-regulation/responses to defoliation/LS covering

• Anthesis+15 days
• Anthesis+25 days

GW and GN from treatments compared to the control

Gemma Molero
GW response to de-graining and grain yield

Modern high yielding CIMMYT cultivars may have co-limitation of grain growth by source and sink

- Variation in source-sink balance or response to de-graining
- Markers for GW response to de-graining 294 WAMI genotypes 2013 (9k SNP and 1,992 DArT markers)

Eliseo Trujillo and Sivakumar Sukumaran

2011 – 2013, 26 CIMCOG cultivars
Relatively small grain weight (GW) responses (10.2%) to defoliation in relation to ca. 40% reduction in LI indicated that source limitation is not entirely dependant on leaves and the potential contribution of photosynthesis from alternative organs such as spike and/or leaf sheath.
Leaf sheath (LS) photosynthesis inhibition reduced GW by 10.4%, indicating leaf sheath makes a significant contribution to grain growth during grain filling.
Photosynthesis up-reg. measurements

**Spike photosynthesis**

Trends for increased spike and flag leaf photosynthesis in the leaf sheath covering treatment compared to the control.

**Flag leaf photosynthesis**

4 CIMMYT spring wheat cultivars 2014, two stages averaged.
Leaf sheath after flowering

- It contributes to photosynthesis during grain filling and final GW, especially in source limited varieties.
- Considerable DM investment within stems.
- Leaf sheath stay-green
- Canopy architecture
- WSC transport role (12.1% at GS65+7 days)
- Stem support
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<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Sheath % to straw Ant+7d</th>
<th>Sheath % to straw PM</th>
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<tr>
<td>BABAX/LR42</td>
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<td>BECARD/KACHU</td>
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<tr>
<td><strong>Mean</strong></td>
<td><strong>0.23</strong>*</td>
<td><strong>0.23</strong></td>
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</tbody>
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Thanks for your attention!