Linking root and shoot:
Traits and trade-offs in low nutrient stress tolerance of cultivated sunflower

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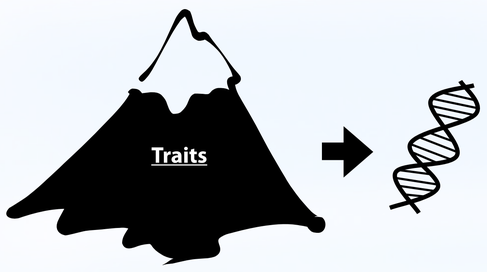
Low nutrient stress in cultivated sunflower

In the greenhouse 2304 plants were grown in 7.5L pots with 80g (high nutrients) or 8g (low nutrients) of slow release fertilizer (NPK 15-9-12) and harvested at budding (R2 stage). At harvest, we measured:

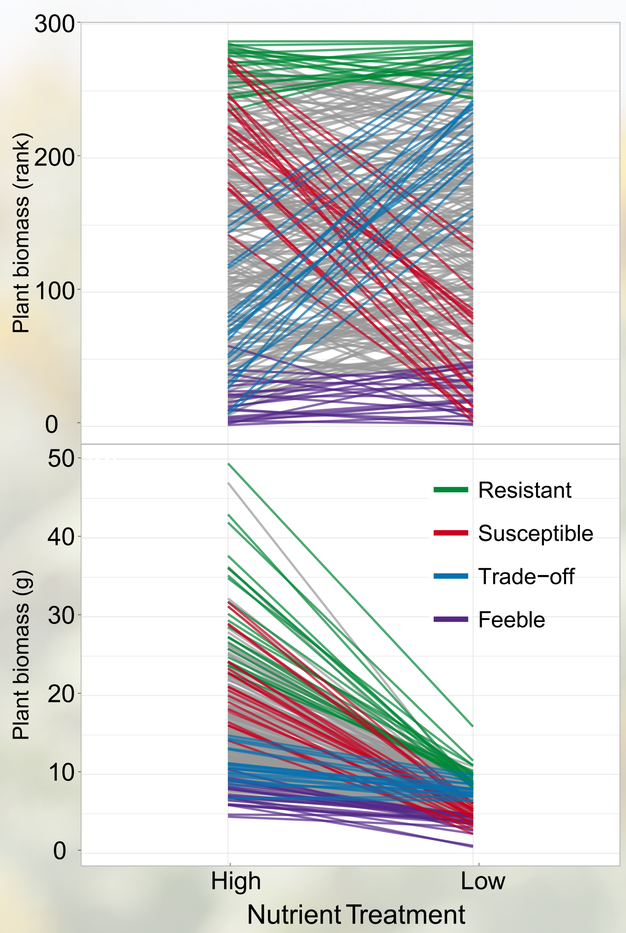
- Biomass accumulation
- Biomass allocation to leaves, stem and roots
- Plant height
- Specific leaf area
- Specific root length/volume
- Nitrogen content
- Chlorophyll content



No inherent trade-off in resistance under stress

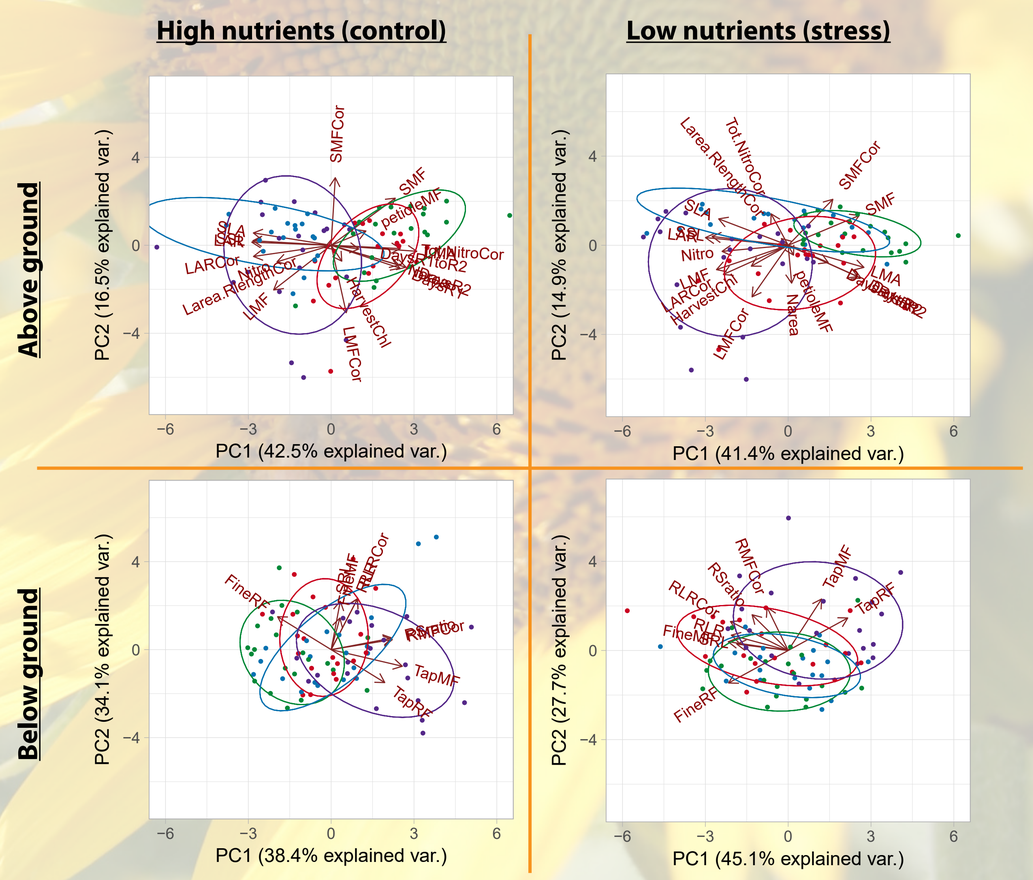
- By using a diversity panel of 287 inbred lines of cultivated sunflower as a model (Mandel et al. 2011 Theor. Appl. Genet.) we investigated whether there is a genetic basis to trade-offs in performance under low nutrient stress and whether above and below-ground morphological and physiological traits can be used to predict that trade-off.
- Results suggest that in cultivated sunflower there is no inherent trade-off in nutrient stress tolerance and that root traits play an important role in sunflower response to stress.
- The lack of an inherent trade-off to nutrient stress resistance highlights the potential for breeding more resilient crops, easing demands on food production due to rising population levels and climate change.

Four response groups based on ranks



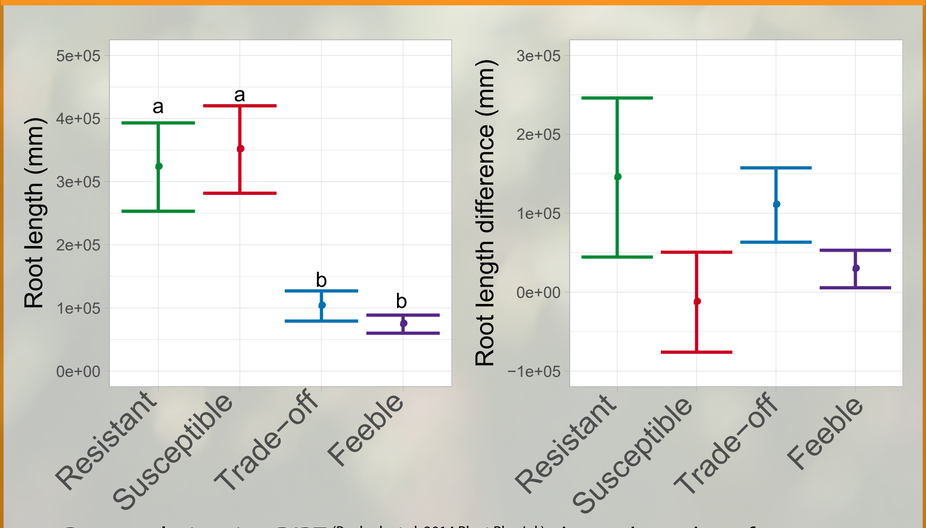
- Genotypes could be categorized into four main groups, resistant (consistently high ranking), susceptible (large rank decrease), trade-off (large rank increase) and feeble (consistently low ranking).

Response groups cluster on above and below ground traits



- Principal component analysis of 23 biomass independent traits of 20 genotypes clearly assignable to each group definition showed groups separating along PCs.
- Belowground ,"Trade-off" genotypes adjust traits to match consistent high performer "Resistant" genotypes.

Root length is a key trait in group identity



- Root analysis using DIRT (Bucksch et al. 2014 Plant Physiol.) showed good performance at high nutrients is associated with high root length.
- At low nutrients good performance appears to be linked to a large increase in root length.

Several genomic regions of interest for multiple traits

Ongoing genomic analysis focuses on determining the genetic basis of key traits under high and low nutrient conditions (GxE).

Using a UGA developed analysis pipeline (Masalia *et al.* in prep) we analyzed over 600k SNPs using EMMAX (Kang *et al.* 2010 Nat. Genet.) to calculate variant effect sizes.

Plots illustrate regions on chromosomes and their effect size.