Generation Challenge Programme

CULTIVATING PLANT DIVERSITY FOR THE RESOURCE-POOR

2008 Project abstracts

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Generation Challenge Programme (GCP)
Hosted by CIMMYT
(Centro Internacional de Mejoramiento de Maíz y Trigo;
the International Maize and Wheat Improvement Center)

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Deviations from workplan

Sequence analysis of representative mismatches (putative SNPs) at candidate genes in rice required longer than expected to convert them to SNP identitites. These results are now being analyzed, and these results compared to haplotype mismatch patterns. Further candidate genes for reproductive-stage stress tolerance are being screened.

Next steps

This project validated the potential to detect SNPs in key candidate genes. Another output, not funded by this project, was the ability to link these polymorphisms to trait variability. A new commissioned project (G4008.5) is building on the vegetative-stage phenotyping for drought tolerance. Accessions that were used for EcoTILLING will be phenotyped for drought response at reproductive stage, the most sensitive period to stress. Two additional publications are in preparation – the association of SNPs in drought candidate genes with vegetative-stage pheonytpes and the utility of EcoTILLING as a biosystematics tool for the AA genome species of rice.

References

Raghavan C, Naredo MEB, Wang H, Atienza G, Liu B, Qiu F, McNally KL and Leung H (2007). Rapid method for detecting SNPs on agarose gels and its application in candidate gene mapping. Mol Breeding. 19:87-101.

28. G4005.06: Supporting emergence or reference drought tolerance phenotyping centers - Drought phenotyping network

April 2005–December 2007; no-cost extension to June 2008

Principal Investigator

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Collaborating institutions and scientists

- EMBRAPA Rice and Beans: Cleber M Guimarães and others
- EMBRAPA Mid-North:: Edson A Bastos and Others
- EMBRAPA Wheat and Savannah: Walter Q. Ribeiro Júnior and Others
- EMBRAPA Semi-Arid: Luiz B. Morgado and others

Research activities and progresses

The project developed and made useful phenotypic evaluation protocols for cereals (maize, sorghum, rice, and wheat) and legume crops (common bean and cowpea), and established phenotyping site specific experimental (SSE) areas of excellence (2) and reference (5) for drought tolerance (DT) studies according to specific climatic condition, soil physical and chemical properties, with laboratories, controlled environment target fields and greenhouses, training unit for researchers and assistants, with facilities and well defined dry season periods to assure total irrigation and soil moisture control during the drought phenotyping field trials. Overall, the project established a scientific and service network for drought tolerance phenotyping in Brazil.

Irrigation Water Application, Control and Management: The irrigation systems installed in the SSE areas are: conventional sprinkler, localised (drip), and continuously moving straight lateral or linear-move systems. These irrigation systems were tested and evaluated for water distribution uniformity and applied water depths by means of measuring and controlling water pressure, flow rate, radius of throw, and emitters or sprinklers spacing. The water depths applied in the irrigations were measured in collectors or catch cans in each genotype field plot. These collectors were placed transversally to the crop rows following a rectangular grid or a transect layout in the plots. The uniformity of the water distribution in the irrigated plot was set to be equal or greater than 95 % (Christiansen). The irrigation water application rate was set to be lower than basic soil saturated water infiltration rate in order to avoid surface runoff, which was not allowed. ***Climatic Condition*** was characterised and hydrological water balance (Thornthwaite & Mather) was determined with 15 to 50 years data series, obtained from standard weather stations. A standard procedure was established to calibrate and install the equipments and sensors of automatic weather stations in each SSE, configured to register automatically the main microclimatic surface parameters locally, with intervals of half to one hour. ***Irrigation water management*** was carried out by means of reference evapotranspiration (ETo) and crop evapotranspiration (ETc) computation, using both class A pan and modified Penman-Monteith equation methods, with the crop (kc) and pan (kp) coefficients. The ETc was determined by multiplying ETo for each genotype crop coefficient (Kc). Irrigation management strategy and irrigation timing criteria were performed based on spread sheet (Excell) for ETo and ETc computation and soil water balance within the root system depth determination, associated with the measurements of soil water content in different layers. The irrigation was uniform after sowing, germinating, and stand formation with 100% replacement of the ETc and soil water availability (SWA) - non water stressed condition. Afterwards, the water stress treatments were obtained with different replacement level of the ETc, generating different application of water depths in the plots, and consequently different SWA, at pre-defined crop growth phases, defined for each genotype, according to breeder, physiologist, and irrigation engineers' indication in order to induce the water stress intensity. ***Soil water content***, in different soil layers, was monitored by gravimetric method and other equipments and sensors (gypsum block, Diviner, tensiometer, neutron probe).

Tangible outputs delivered

Phenotyping SSE areas: 2 Embrapa´s Centres of Excellence (Sete Lagoas-MG & Santo A. de Goiás-GO) and 5 Embrapa´s Sites of Reference (Janaúba-MG, Porangatu-GO, Teresina-PI, Planaltina-DF, Petrolina-PE) for DT studies. ***Soil physical and chemical properties*** characterised for each environment site. ***Irrigation system schemes*** (conventional sprinkler, linear moving sprayer lateral line, drip) installed and evaluated for each environment site with water flow rate and management monitoring devices (hydrometer, collectors kit, pressure meters). ***One automatic weather station installed*** in each environment site with microclimatic data registered. ***Soil-water content & availability*** controlled, measured & registered in each environment site in the soil root system profile. ***Irrigation water application and soil-plant water stress*** controlled and monitored for DT phenotyping in each cereal and vegetable genotype (at predefined crop growth stage) / environment site. ***Plant-water content*** measured and registered for some genotypes in some environment site. ***Genotypes tolerant and sensible***: a reasonable number of genotypes (access and selected materials for maize, sorghum, rice, wheat, common bean, cowpea) were phenotyped and the main contrasting genotypes (tolerant and sensible) to drought were identified and selected. ***Database***: all the project information and data were transferred into database (Morpho) for each environment target site.

Future research

Next steps and/or challenges: Mechanisms investigation for drought tolerance for each crop specie studied.

References

Project Team (2008). Supporting Emergence or Reference Drought Tolerance Phenotyping Centers, Drought Phenotyping Network- DPN. Proceedings of the final project workshop, 17-18 June 2008, Gomide, R. L. ed., Embrapa Maize and Sorghum, Sete Lagoas, MG, Brazil, pp. 171.

29. G4005.07: Whole plant physiology modelling (WPM)

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1. Context: WPM was initiated as a complementary project to Drought Phenotyping Network (DPN, Embrapa). Its concepts date back to 2004 Phenotyping meeting (Montpellier) aiming at improving phenotyping methods and capacities in GCP. While DPN was designed to physically develop a field drought phenotyping network across Brazil, WPM was conceived as a series of relevant case studies, with the objective to apply, prove or improve the potential of plant/crop modelling for: **Component 1 (C1)**: assisting in characterizing Target Population of Environments (TPE) met by a breeding programme; (**C2)**: assisting field phenotypic analysis, by extracting, from complex observed traits, elementary traits (model parameters), assumed to be less polygenic and less E dependent and thus more adapted to genetic studies; (**C3)**: assisting ideotype behavior analysis (*in silico* trait combination) or trait impact on plant performance in TPE.

2. Findings and implications

C1: The main C1 study was successfully conducted on upland rice and maize TPEs for the Brazilian Cerrados using SARRAH model. The main result (Heinemann et al. 2007) was that current breeders' screening sites are not representative of the TPE regarding drought intensity and probability, but that drought is generally not a severe constraint in