Supporting Emergence or Reference Drought Tolerance Phenotyping Centers - Drought Phenotyping Network

Generation
Cultivating Plant Diversity for the Resource-Poor

Embrapa

CIMMYT
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STRUCTURE, MAINTENANCE AND MANAGEMENT OF A DATABASE FOR DROUGHT TOLERANCE PHENOTYPING

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INTRODUCTION

All the project data produced are related to microclimatic condition, soil-water status and soil water availability in the soil profile (effective root system region), crop water requirement and water stress, soil physical and chemical properties, and selected number of genotypes materials for each crop specie studied (maize, sorghum, rice, wheat, common bean, cowpea) with their traits evaluation, yields, and yields components for drought tolerance Phenotyping. These data were transferred into database for all the contrasting environment sites studied.

DATABASE

All the data sets were posted in the Morph database and are available for the project team, Embrapa Units, and GCP involved in this research by means of internet access.

Morpho is data management application free software, designed to assist researchers in managing this heterogeneous collection of data. It was developed with the goal to ease the burden of data management on scientists while improving access to and documentation for scientific and ecological data. Morpho allows scientific and ecological researchers to describe their data using a comprehensive and flexible metadata specification, and to share their data publicly or to specific collaborators over the Knowledge Network for Biocomplexity (KNB). Morpho's main Characteristics include:

1) flexible metadata creation and editing using an XML syntax for metadata exchange;

2) a 'wizard' interface for collecting metadata;

3) automated metadata extraction while importing data;

4) an XML editor that is configurable using multiple XML DTDs;

5) compliance with the Ecological Metadata Language;

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6) powerful metadata search on the network or locally; and,

7) comprehensive revision control for data and metadata.

DIGITALIZATION AND INSERTION OF PROJECT DATABASE INTO MORPHO

All the data and information, generated in the experiments of the different sites, per different crop species, were digitalized in documents and tables of the Microsoft Word, and spreadsheets of the Excel. Later these digitalized data were inserted in the system called "*Morpho***"**, which is a data management tool for ecologists, agronomists, and others researchers scientists (Figure 1). The Morpho's opening screen is presented in Figure 1, where it can be seen how to create a new project profile, how to login to network using a current profile, and how to work with database. In the option "Work with your data…" there are the following alternatives:

1) Create a new data package … <name>;

2) Open an existing data package … <name>; and

3) Searching for an existing data package … <name>.

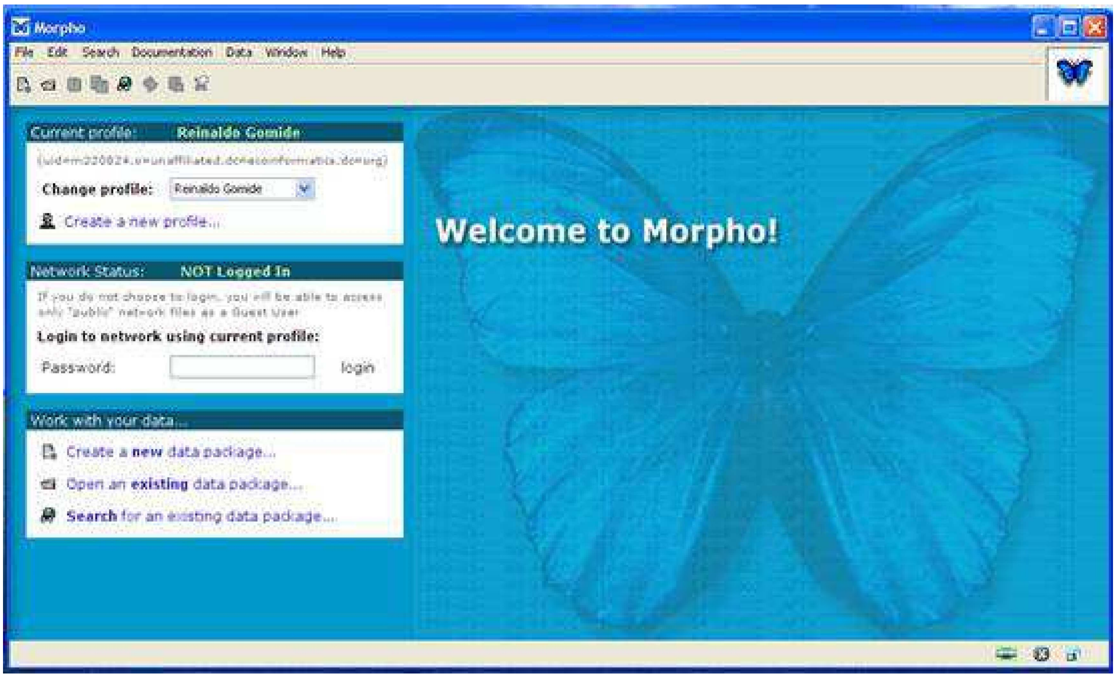
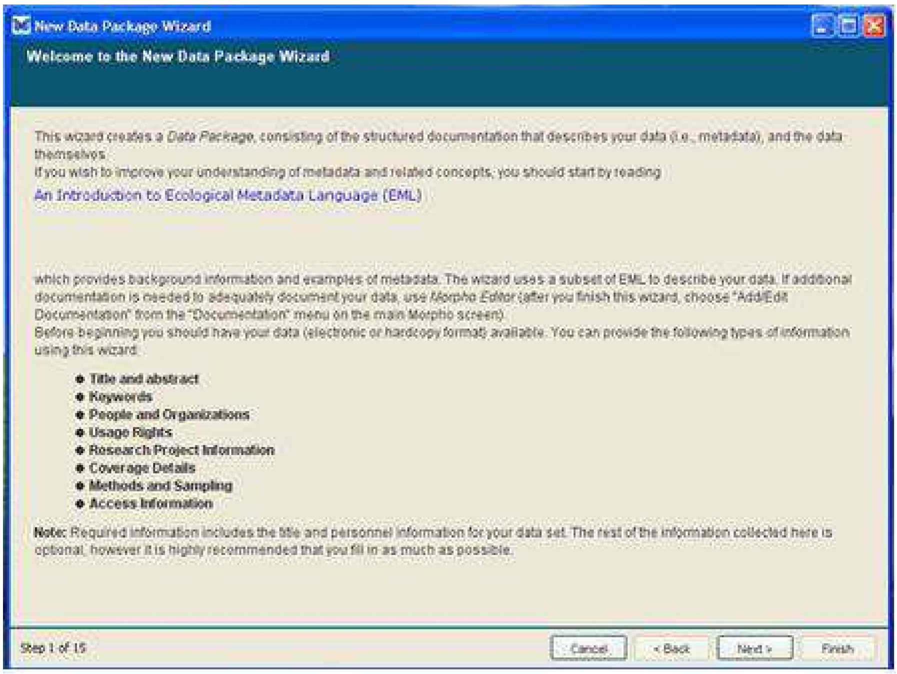


Figure 1. Morpho's opening screen illustrating how to create a new project profile, how to login to network using a current profile, and how to work with a given database (create, open, and search).

Morpho is a component of the Knowledge Network for Biocomplexity (KNB) and was created to provide an easy-to-use, cross-platform application for accessing and manipulating metadata (e.g. documentation) and data (both locally and on the network). The KNB is an international data repository dedicated to facilitating ecological and environmental research on biocomplexity. It enables the efficient discovery, access, and interpretation of data ranging from individual researcher efforts to highly distributed field stations, research sites, and laboratories.

Figure 2 shows Morpho's screen menu for "New data package wizard", which allows researcher to create metadata, (*i.e. describe their data in a standardized format*), and create a catalog of data and metadata upon which to query, edit and view data collections.

Morpho provides the means to access network servers (Figure 1), in order to query, view and retrieve relevant data. Many types of "data" can be used with Morpho, including data tables and images. Morpho provides the means to access network servers, in order to query, view and retrieve relevant data. In the case of this project a specific server will be used, to be offered by Embrapa, for manager the use and the manipulating of the data generated at the different phenotype sites (Figure 3).



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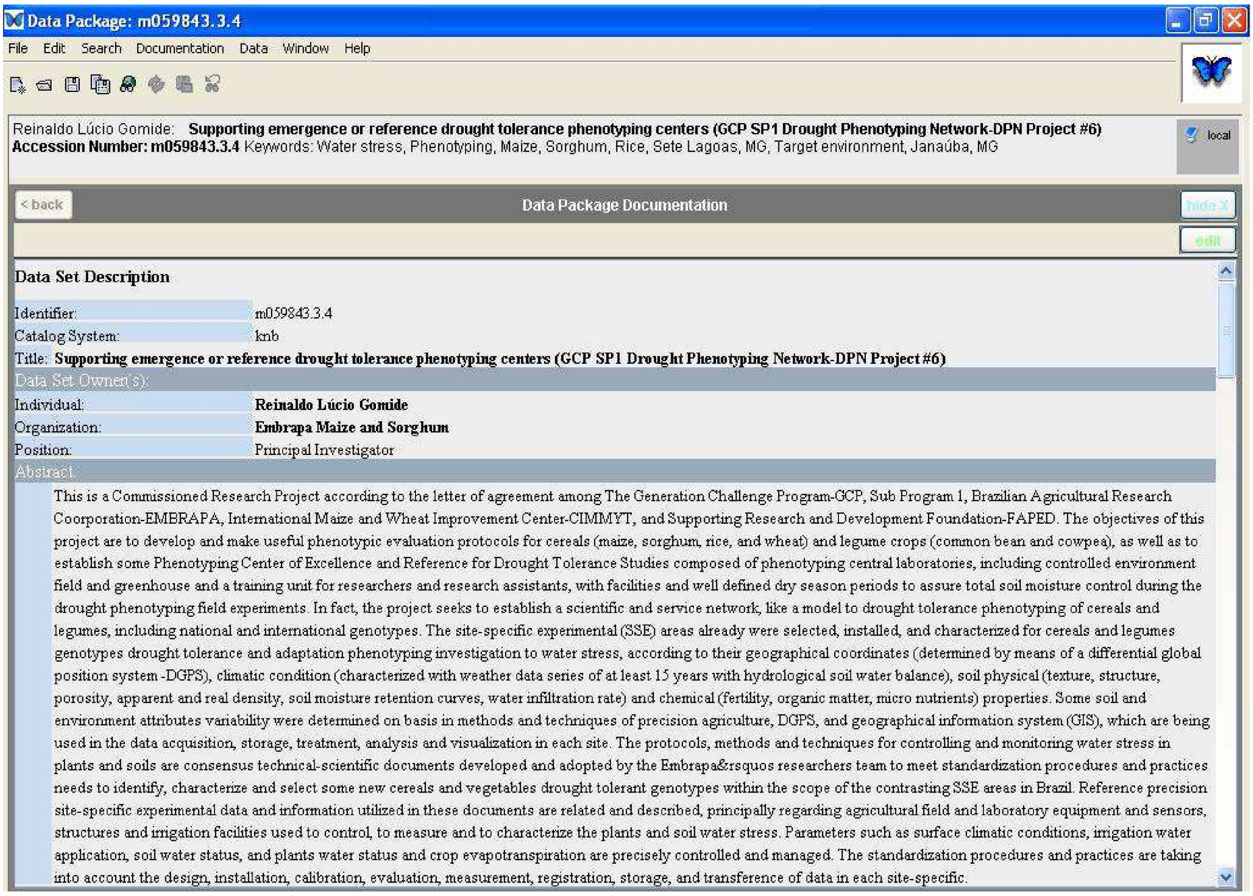

Figure 3. Supporting emergence or reference drought tolerance phenotyping centers project data package identification inserted on the Morpho's database.

Figure 4 shows the digitalized project methods information inserted in different steps into the Morpho database. Step 1 is describing the precision site-specific experimental areas for drought tolerance phenotyping in the different Brazil regions. Step 2 is presenting the project protocols, methods, and techniques for controlling and monitoring water stress in cereals and legumes genotypes. The irrigation systems and irrigation water management / climatic condition and hydrological water balance information were insert through step 3 and 4, respectively. Step 5 contains soil water status controlling and management methodology utilized in the project.

Methods Info

Step 1:

Description:

Precision Site-Specific Experimental Areas for Drought Tolerance Phenotyping in Brazil Regions

The site-specific experimental (SSE) areas already were selected, installed, and characterized for cereals and legumes genotypes drought tolerance and adaptation phenotyping investigation to water stress, according to their geographical coordinates (determined by means of a differential global position system -DGPS), climatic condition (characterized with weather data series of at least 15 years with hydrological soil water balance), soil physical (texture, structure, porosity, apparent and real density, soil moisture retention curves, water infiltration rate) and chemical (fertility, organic matter, micro nutrients) properties. Some soil and environment attributes variability were determined on basis in methods and techniques of precision agriculture, DGPS, and geographical information system (GIS), which are being used in the data acquisition, storage, treatment, analysis and visualization in each site. The spatial variability of soil physical (texture, structure, macro and micro porosity, apparent and real density, soil moisture retention curves, water infiltration rate) and chemical properties (organic matter, fertility, some micro nutrients) was evaluated by means of topographic survey and division of the sites areas in grids of 25 m x 25 m, utilizing a accurate survey laser total station Topcon Hiper and DGPS, on SAD-69 datum and UTM projection (south zone 23, 48 W a 42 W). Samples of the referred soil properties were collected in the grid intersections. Soil properties contour maps were obtained by interpolation with geostatistic adjusted models (krigagem). These maps were used to divided the sites-specific areas in uniform zones for abiotic water stresses studies in cereals and vegetables genotypes. In each selected site area, the water table was deep in order to avoid soil water capillarity effect in the genotypes root systems, and it was identified high and low points in order to avoid drainage problems.

Step 2:

Description:

Protocols, Methods and Techniques for Controlling and Monitoring Water Stress in Cereals and Legumes Genotypes for Drought Tolerance Phenotyping

The protocols, methods and techniques for controlling and monitoring water stress in plants and soils are consensus technical-scientific documents developed and adopted by the Embrapa&rsquos researchers team to meet standardization procedures and practices needs to identify, characterize and select some new cereals and vegetables drought tolerant genotypes within the scope of the contrasting SSE areas in Brazil. Reference precision site-specific experimental data and information utilized in these documents are related and described, principally regarding agricultural field and laboratory equipment and sensors, structures and irrigation facilities used to control, to measure and to characterize the plants and soil water stress. Parameters such as surface climatic conditions, irrigation water application, soil water status, and plants water status and crop evapotranspiration are precisely controlled and managed. The standardization procedures and practices are taking into account the design, installation, calibration, evaluation, measurement, registration, storage, and transference of data in each site-specific.

Step 3:

Description:

The Irrigation Systems and Irrigation water management

The irrigation systems that are being used in the SSE areas are: conventional sprinkler (low to medium service pressure), localized (drip or trickle), and continuously moving straight lateral or linear-move system. The irrigation systems were tested and evaluated for water distribution uniformity (flow rate/discharge) or applied water depths by means of defining and controlling water pressure, flow rate, radius of throw, and emitters or sprinklers spacing. The water depths applied in the irrigations are being measured in collectors or catch cans in each genotype field plot, which are being placed (layout) transversally to the crop rows. The uniformity of distribution of the water in the irrigated plot was set to be equal or greater than 95 % (Christiansen Uniformity Coefficient or CUC = 95%). Some hydrometers are being coupled to the irrigation systems main lines. Every where, irrigation water application rate is being set to be lower than basic soil saturated water infiltration rate in order to avoid surface runoff, which is not allowed in the SSE areas.

Irrigation management are being carried out through computation of reference evapotranspiration (ETo) and crop evapotranspiration (ETc), using both class A pan, modified Penman-Monteith equation methods, and also the crop (kc) and pan (kp) coefficients. The ETc is being determined by multiplying ETo for each genotype crop coefficient (Kc). Irrigation management strategy and irrigation timing criteria establishment are being performed based on a spread sheet (Excell) for ETo and ETc computation and a monitoring of soil water content in different depths. The irrigation is uniform after planting, germinating, and stand formation with 100% replacement of the soil water availability (SWA) and ETc - non water stressed situation. The water stress treatments are being obtained with different replacement level of the ETc and SWA, generating different application of water depths in the plots at pre-defined crop growth phases, defined for each genotype, according to breeders and physiologists indication in order to establish the water stress.

Step 4:

Description:

Climatic Condition and Hydrological Water Balance

In each site-specific experimental area climatic condition was characterized and hydrological water balance (Thornthwaite & Mather) was determined with 15 to 50 years data series from standard weather stations (Brazilian National Institute of Meteorology &ndash INMET). A standard procedure was established to calibrate and install the equipments and sensors of automatic weather stations in order to register automatically the microclimatic surface parameters locally for drought tolerance phenotyping purposes. Climatic surface data are being registered by means of automatic weather station, configured to measure temperature and relative humidity of the air, global solar radiation (net radiation in some), precipitation, speed and direction of the wind, class A pan water evaporation (in some) with half to one hour intervals.

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Step 5:

Description:

Soil Water Status Controlling and Management

Soil water content, in different soil layers, is being monitored by gravimetric method (the protocol consists of locating the soil moisture site, decide upon the sampling frequency and strategy, and assemble the necessary materials, collecting soil samples with an auger, weighing, drying in oven overnight and reweighing soil samples), equipments and sensors. The gypsum blocks sensors are being used for continuous monitoring of soil water content. These sensors are being calibrated by means of the gravimetric method &ndash taking measurements of the electrodes (inside the porous blocks) electrical resistance (electrodes involved in known soil reservoir and embedded in water until saturation) against its water content by weighing. The wetter is a porous block, than the lower is the resistance measured across two embedded electrodes. This type of sensor is suited to various irrigation applications mainly with soil water stress condition. These sensors are being left in field to automatically monitor continuously soil moisture, allowing many replicates. The time domain reflectometers (TDR) equipment combine the knowledge of the waves signal propagation velocities in the presence of water in the soil medium, which affects the speed of these electromagnetic waves (slows them down slightly). The accuracy of TDR measurements depends on precise measurement of time and precise calibration with the relative volumetric content of water around the probe. The soil sampling and sensors installation to register soil water content are being made in at least four soil depths (15, 30, 50, and 80 cm).

Project Info

Title: The GENERATION Challenge Program - Cultivating Plant Genetic Diversty for the Resource Poor

Personnel:

Individual:	**Jean-Marcel Ribaut**	
Organization:	**The Generation Challeg Program**	
Position:	Director	
Role:		Director
Individual:	**Jean Christophe Glaszmann**	
Organization:	**Generation Challeng Program - SP 1 Genetic Diversity o Global Genetic Resources**	
Role:		Sub Program Leader

Figure 3. Digitalized project methods information inserted in different steps into the Morpho database.

Higgins, D.; Berkley, C.; Jones, M.B. Managing heterogeneous ecological data using Morpho.. In: Proceedings of the 14th International Conference on Scientific and Statistical Database Management, 2002. pp 69 – 76.