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Short Communication

Genebank data-management software incorporating seed-viability test results

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Abstract

The National Institute of Agrobiological Sciences' (NIAS) Genebank is the coordinating institute in Japan for the conservation of plant, microorganism and animal genetic resources related to food and agriculture. The NIAS Genebank manages this activity in collaboration with sub-banks located across Japan and acts as the central bank. It is important for genebanks to maintain the viability of genetic resources during conservation. Generally, seeds are stored at low temperature and low humidity. Germination percentage is used to monitor seed viability. We have developed data-management software to manage germination testing data in the NIAS Genebank. The software can monitor the pattern of the loss of seed viability of each accession and also support the selection of accessions that need regeneration of seeds. Web-based plant accessions search software displays the latest data on the availability and germination percentages of accessions.

Keywords: database; genebanks; germination; management; Web-based system

Experimental

Data management of germination testing

The National Institute of Agrobiological Sciences (NIAS) of Japan manages the NIAS Genebank Project for the conservation and distribution of plant, microorganism and animal genetic resources related to food and agriculture (Okuno *et al*., 2005; Takeya *et al*., 2012). The NIAS Genebank classifies, evaluates, multiplies and preserves genetic resources collected in Japan and overseas. It coordinates the distribution of resources in the public domain for research and educational purposes in collaboration with sub-banks located across Japan.

It is important for genebanks to maintain the viability of their genetic resources. The overall germination percentage is usually used to monitor seed viability (FAO/IPGRI, 1994; van Hintum and van Treuren, 2012). Germination data must be managed efficiently to support the effective storage of plant genetic resources in genebanks, as, for example, in GRIN-Global (2012). We have developed data-management software to support the effective conservation of accessions using germination percentage data. Although Web-based plant accessions search software had already been developed (e.g. EURISCO, 2012; GRIN, 2012), up-to-date information on germination percentages is not always easily accessible online. Our plant accessions search software is designed to overcome that limitation and now provides this information for

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accessions in the NIAS Genebank (http://www.gene.affrc.go.jp/databases-plant_search_en.php).

Genetic resources databank

The genetic resources database in the NIAS Genebank records the passport, characterization, evaluation and storage datasets of plants, microorganisms and animals. 'JP number', a unique identifier, is assigned to each plant accession, and the datasets described above are linked by this JP number. We have developed data-management software for genebank workers to manipulate easily the input and updating of data in the database. The results of germination tests are included in the storage dataset.

Programming environment

The genetic resources database is implemented in the Informix Dynamic Server (IBM) database management system (DBMS). Most of the data-management software has been created in the Informix-4GL programming language. The character-based data-management software, running in a terminal emulator, allows expert users to manipulate data quickly.

The Web retrieval database is implemented in the MySQL DBMS (Oracle). Web-accessible programs, such as the plant accessions search software, have been developed in the PHP and JavaScript scripting languages. The Web retrieval database was designed for an efficient search performance as denormalized forms by joining many tables in the genetic resources database. Part of the genetic resources database for Web-accessible programs is transferred into the Web retrieval database on a daily update basis by a program written in Perl (Takeya *et al.*, 2011).

Seed storage

Sub-banks send regenerated seeds to the central bank, and then the central bank performs an initial germination test using a subset of the seeds (Fig. 1). The data-management software registers the total germination percentage and quantity of seeds for each specific seedlot in the database, and the seeds are then stored. Seeds for long-term conservation are stored at −10°C and 30% relative humidity (RH). Seeds for distribution are conserved at −1°C and 30% RH. All the procedures of storing and retrieving accessions to and from the seed storage room are automated by using a robot system controlled by a computer, so the operator does not need to enter into the cold storage room.

Data-management software

The 'germination test program' (Fig. 1) selects seedlot for germination testing and later registers the total germination percentage and any remarks on seed quality. The 'selection of candidate accession for regeneration'

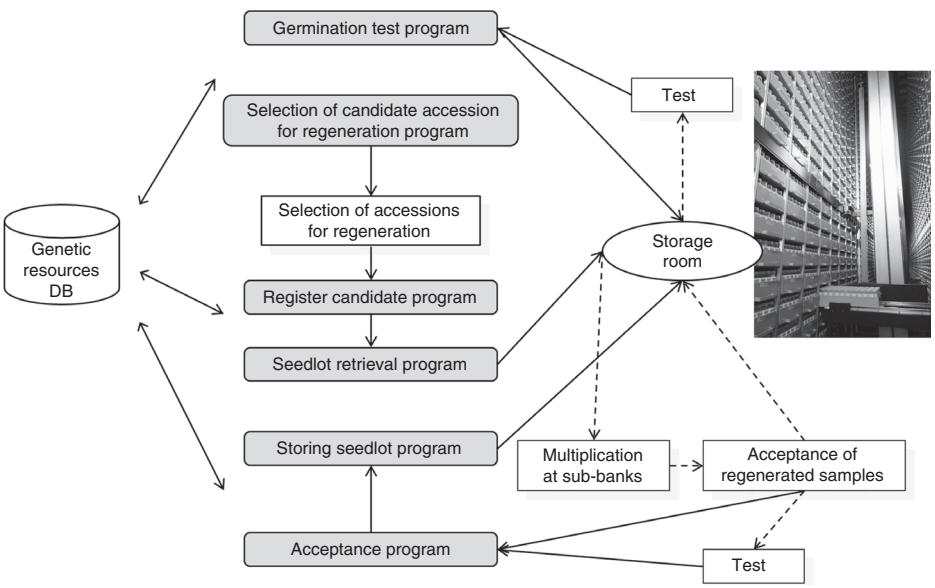

Fig. 1. Schematic diagram of the germination-test and storage-control system used to manage the plant genetic resources stored in the NIAS Genebank. Rounded rectangles, data-management programs; solid arrows, data flow; dashed arrows, seed flow. DB, database.

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program provides a list of candidates for seed regeneration mainly based on the germination data that were tested at 5-year intervals. Scheduling of the germination test is an important issue for genebank management. A seed viability model for scheduling the germination test has been developed (e.g. Walters *et al.*, 2005; Trapp *et al.*, 2012). We may consider the application of this model in our new system. The genebank manager selects seedlots to be regenerated, considering germination test results and the quantity of the remained seeds. The 'register candidate' program records the lot number of the seed samples selected for regeneration. The operator selects the seedlot for regeneration using the 'seedlot retrieval' program and picks out the seed bottle from the container to send seeds to the sub-banks. When the central bank receives the regenerated samples from the sub-banks, a portion is used for the germination test. Seeds with a lower quality than that of seeds currently held in the NIAS Genebank are refused. The 'acceptance' program registers germination percentages, seed quantities and the information related to multiplication. The 'storing seedlot' program stores the seed bottle in a designated container in the distribution-seed-storage room.

Availability-management system

The germination percentage and the remained quantity of seedlot for an accession are used as the criteria for deciding the availability of the accession. The 'availability management' program updates the availability information daily (Fig. 2). The current procedure is as follows. First, for each JP number accession, the program retrieves the latest germination-test result, the remaining seedlot quantity and the generation data. Then, if an accession has germination percentage $\geq 1\%$, seedlot quantity $2 \times$ [standard distribution quantity] and generation > 0, that accession is categorized as 'available for distribution'. The standard distribution quantity depends on the crop species; for example, within the NIAS, for rice and barley, it is 7.0 g, and for wheat, 10.0 g. The original seedlot is assigned to generation 0, and the generation number increases from the previous generation by the procedure of regeneration. The available accessions are indicated as 'Yes' in the 'Availability column' in the list provided by the Web retrieval database (Fig. 2).

When a request for a plant genetic resource comes in, the genebank manager reconfirms the availability. The 'distribution' program registers the requested accessions.

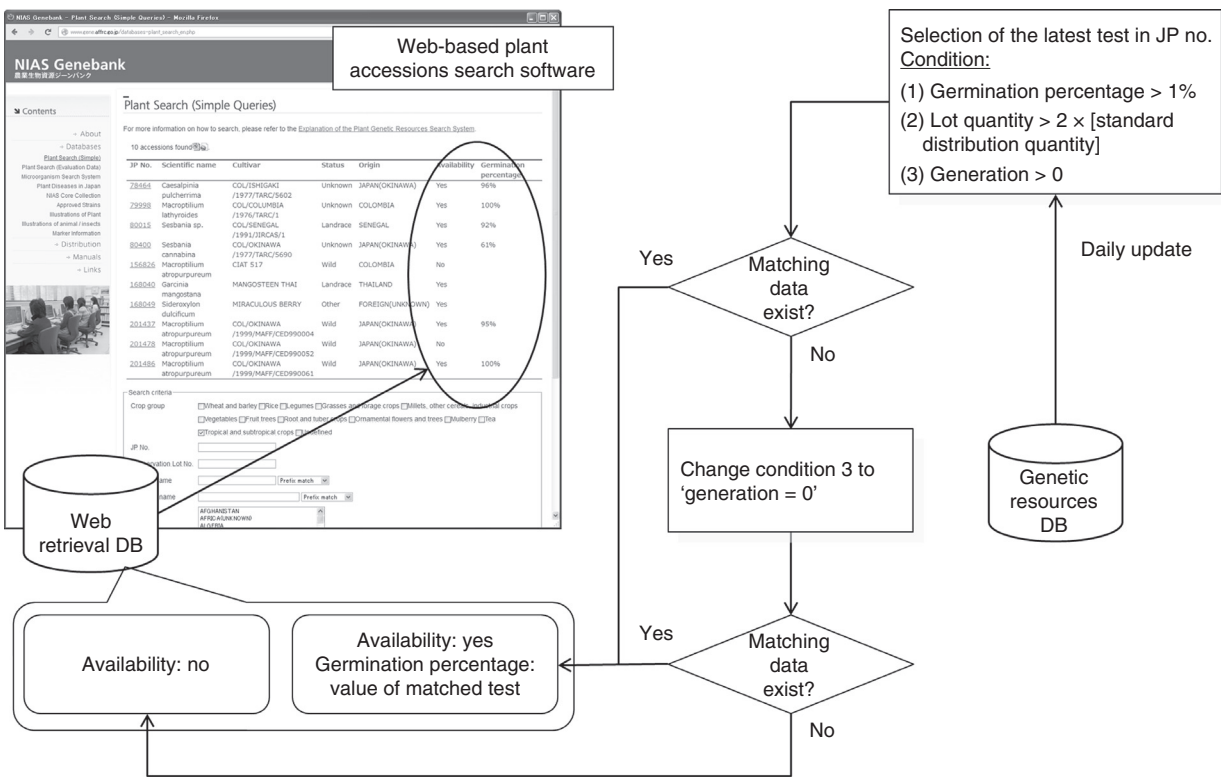

Fig. 2. Schematic diagram of the availability-management system, with an example of germination-test results. Data are updated daily. DB, database.

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Operators can select the preferred seedlot in consideration of the germination percentage and the remained seed quantity displayed. Then, the 'seedlot retrieval' program brings the containers including the requested accessions. Seeds of generation 0 may be distributed if no other seeds are available.

Discussion

Good management of germination data is important to support the effective storage of plant genetic resources. Germination data may be used for considering storage-environment and scheduling viability-tests. The new data-management system described herein improves the operation of the NIAS Genebank. Inclusion of the germination percentage in the database allows customers to request high-quality seeds. Up-to-date information on germination percentages is always shown with the searched accessions list.

Many programs control the storage of plant genetic resources. Although the number of programs is large, the efficiency and consistency of further developments can be improved by the use of common modules and functions.

Future improvements will include the use of artificial intelligence to identify unusual data.

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