

# Prospects for the development of electronic databases of the Mangyshlak experimental botanical garden

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**Abstract.** The paper describes four computer programs (BD-PLANT-KZ, DInCeR, PLANT-EST-KZ and Feno-S) designed at the MEBS in relation to the arid conditions of Mangystau for cadastral registration of plants of natural flora (ex-situ); registration and determination of the introduction value of collection plants (ex-situ); diagnosis of aesthetics of green spaces, registration and statistical processing of phenological observations.

The Mangyshlak experimental botanical garden developed 4 applied computer programs on scientific and practical directions of introduction, floristics, green building and phenology: 1) Flora and vegetation study - in-situ ("BD-PLANT-KZ"); 2) Registration and diagnostics of perspective of plants of collection gene pool - ex-situ ("DInCeR"); 3) Inventory and comparative study of aesthetic of green devices ("PLANT-EST-KZ"); 4) Accounting, storage and mathematical processing of phenological observations materials ("Feno-S").

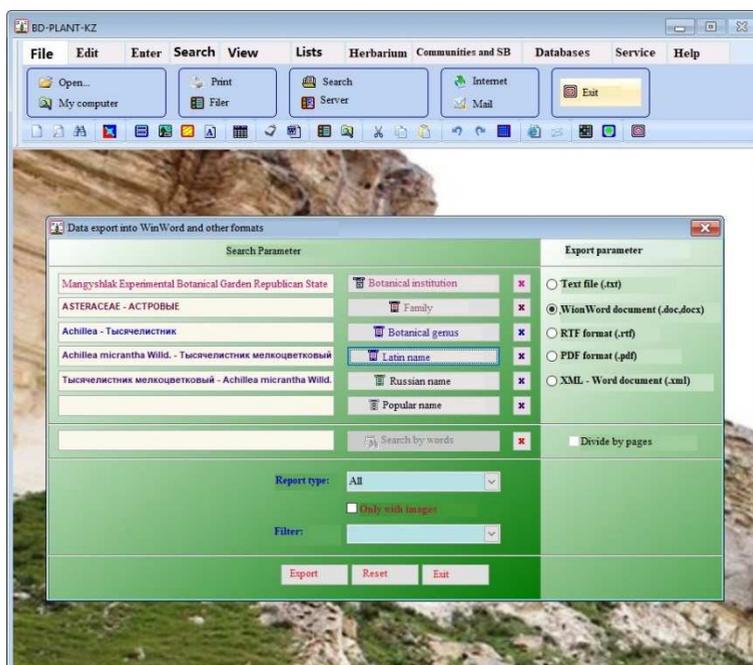
For the cadastre of plants under the program "Development of scientific, methodological and information base for the creation of the cadastre of plants of the Republic of Kazakhstan" was developed a computer program "BD-PLANT-KZ", which allows you to create a database to store information on taxonomic composition, morphology, ecology, economic and biological properties, herbaric samples, natural populations, stocks of raw materials, geographical and floristic distribution areas of higher vascular plants.

The Main Menu (MM) structure included 11 items: "File", "Edit", "Enter", "Search", "View", "Lists", "Herbarium", "Communities and SB", "Databases" (DB), "Service" and "Help" (Fig. 1). Each MM item contains a certain set of commands that solve specific tasks of the program. The "File" item includes standard sub-items for creating new and working with existing files, printing information and exiting the program. The commands of the "Edit" item are necessary for editing active text fields of input forms and viewing information about a plant. The item "Input" is used to start forms of filling of DB with new information and editing of already entered information. The "Search" item allows you to search for plants in the database. The "View" item is used to print and export the contents of the database to external editors in various formats. The Lists item allows you to generate a variety of reports on plants by taxonomic and morphological characteristics. The commands "Input and View", "Reports", and "Export" of the MM "Herbarium" item are designed to

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perform the functions of working with the herbarium stock of a botanical institution. "Communities and SB" includes 3 sub-items necessary for operations with natural populations and seed bank.



**Fig. 1.** Main window of the BD-PLANT-KZ program.

Diverse information about the plant is divided in the input and view forms BD-PLANT-KZ into 11 groups (pages): Taxonomy, Names, Areal, Map, Morphology, Ecology, Application, Additional, Herbarium, Pictures and Text.

To facilitate the input of taxonomic units, the program uses the list of genera of R.K. Brummitt [1]. The systematics is based on the phylogenetic system of A. Takhtajan A. [2].

BD-PLANT-KZ provides formation of various lists of plants according to taxonomic, morphological and other characteristics, as well as export of information in 5 formats (Fig. 1).

I.N. Safronova's geobotanical classification [3]: vegetation type, formation group, formation, association is used to work with plant communities of the desert zone of Kazakhstan. For this purpose a computer form including 5 pages of information is specially provided: Location, Communities, Tiers, Additional, and Figures

BD-PLANT-KZ has been tested in 3 botanical gardens of Kazakhstan on example of entering and working with information for 1074 taxa from 87 families and 310 genera.

Further implementation of the program in the practice of cadastral registration will greatly simplify the creation of electronic databases, will quickly search for taxa and, ultimately, will expand the possibilities of working with information about plants and their communities.

In the conditions of the Mangistau desert, the diagnosis of perspective plants in culture is one of the most important tasks of the introduction process. Widespread in the practice of other botanic gardens developments on this issue are mainly for temperate continental climate and most of them include quite a narrow list of evaluation indicators, giving the highest priority to "winter-hardiness" which is of secondary importance for arid habitat. The earlier developed regional scale for evaluation of introduction value of plants was put into

electronic language in a special computer program "DInCeR". Apart from forecasting of introduction value of plants the program can be used for the following purposes 1) Data entry and storage in computer memory of various registration and ecologo-biological information; 2) Preparation of various lists of families, genera, seed selections, herbarium, their location in the Garden, etc.; 3) Selection of promising assortment and 4) Printing out and export of information in various file formats.

The structure of the developed program reflects its Main Menu, which contains 11 items: "File", "Edit", "Enter", "Search", "View", "Lists", "Herbarium", "Assortment", "Databases", "Service" and "Help".

The program's collection database contains 254 fields of information on 12 pages of input and viewing forms: Taxonomy, Names, Location and Range, Morphology, Biological stability, Ornamental qualities, Re-productive ability, Applications, Additional information, Map, Pictures and Text messages. There are 6 options implemented in the program for quick plant searches: "Any word", "Latin", "Russian name", "Folk name", "Family and name", "Identifier".

The selection of promising assortment is supposed to be performed in "DInCeR" in two ways: by diagnostic features and by introductive value. At the same time, up to 35 taxonomic, diagnostic and ornamental-habitual parameters of interest to the user can be set.

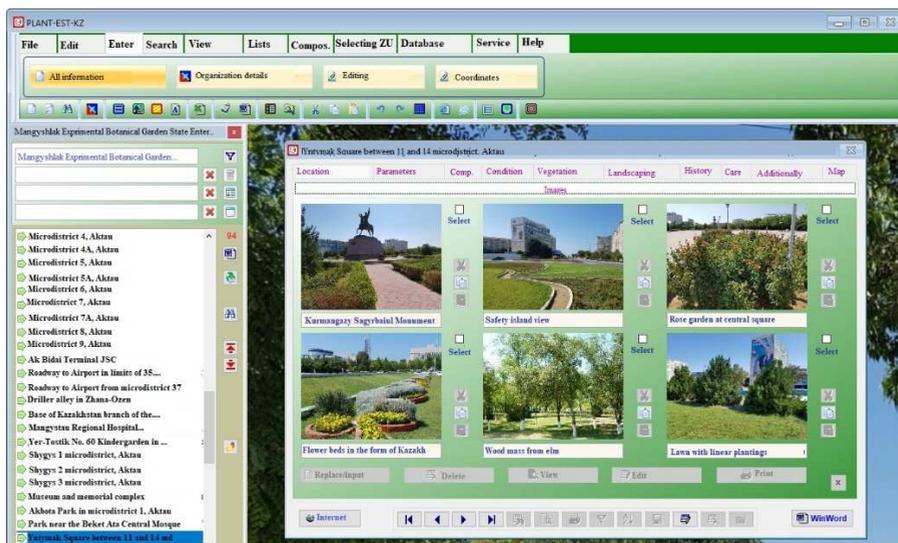
There are records for 1002 introductions of 3 botanical gardens, 6 taxonomic divisions, 9 classes, 14 subclasses, 29 supraorders, 56 orders, 9 suborders, 58 families, and 146 genera.

Advantages of "DInCeR" in comparison with other software of botanical profile are multifunctionality, large number of DB fields, possibility to make various lists, diagnostics of introduction value and selection of plant assortment according to given ecologo-biological indices.

The program PLANT-EST-KZ was created in MEBG, based on the needs of a comparative assessment of ornamentality of landscape gardening and the need for operative development of recommendations to improve the quality of green building in the region (Fig. 2). A "Complex scale of esthetics estimation of green objects" has been mediated in electronic program envelopes, which takes into account 37 structural, memorable, ecological, biological and agro-technical characteristics of landscape and garden objects, combined into five groups (sections): 1) General characteristics and esthetics of objects; 2) Decorative properties, state and abundance of green spaces; 3) Amenities, 4) Cultural, historical and scientific value and 5) Maintenance level of green spaces. The scale is stobal, ranked into 10 classes and indexes of ornamentality. The sum of points 91-100 corresponds to a reference ZU, 81-90 - ZU with a very high aesthetic value, 71-80 - high, 61-70 - increased, 51-60 - average, 41-50 - reduced, 31-40 - low, 21-30 - very low, 11-20 - extremely low. With the sum of points 0-10, ZU has no aesthetic value.

Structurally, the MM of the program contains 11 items: "File", "Edit", "Enter", "Search", "View", "Lists", "Composition", "Selecting ZU", "Databases", "Service" and "Help". On the form of entering and viewing the information, all the information about the land plot is divided into 11 groups: Location, Characteristics, Composition, Condition, Vegetation, Beautification, History, Care, Additional, Map, Pictures (Fig. 2).

The program database contains materials of the survey of 94 green devices of the residential and industrial areas of Aktau, Mangistau region of the Republic of Kazakhstan (59 neighborhoods, seven green areas near office buildings, two descents to the sea, one children's park and 25 urban green areas).



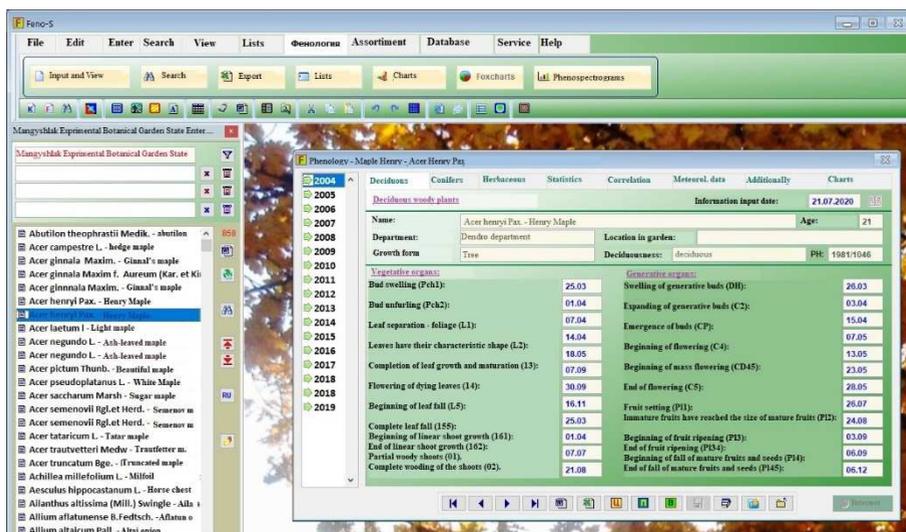
**Fig. 2.** The main window of the BD-PLANT-KZ program with a form for entering and viewing information.

Implementation of the PLANT-EST-KZ program in the practice of green building will become the basis for objective assessment of decorative value of landscaping plantings and development of effective measures for reconstruction of existing and creation of new garden and park plantings and will serve to improve sanitary, hygienic and recreational functions of landscaping facilities.

The computer program Feno-S was developed in the period from 2018 to 2020 during the implementation of the grant project "Development of scientific-methodological and computer-information basis for phenological observations in botanical gardens of Kazakhstan for prediction of perspective of plant introduction and efficient conservation and use of their biodiversity" (Fig. 3). The program is designed for input, storage, mathematical and graphical processing of phe-nodata, as well as identification of pheno-indicators of plant prospects.

All pheno-information in Feno-S is divided into 8 groups (pages): "Deciduous", "Coniferous", "Herbaceous", "Statistics", "Correlation", "Meteorological data", "Additional" and "Diagrams".

On the first 3 pages of the input form it is possible to enter and edit phenodate values for each morphological and systematic group of plants (Fig. 3). On the fourth page of the form, algorithms implemented in the electronic shell allow calculating values of duration of phenological phases (foliage, flowering, growth and wooding of shoots, fruit ripening and falling, etc.), as well as basic statistical parameters for the chosen phenological phase. "Correlation" page is designed for determination of relation closeness in 5 variants: 1) selected phenodate with others; 2) between all phenodates; 3) between years of observation period for all phenodates; 4) all phenodates with meteorological factors and 5) duration of phenological phases with meteorological factors. The "Meteodata" group of attributes is used to enter values of temperature, air humidity and amount of precipitation by months. On the last page of the form, automatic construction of Gantt charts and histograms of duration of 8 pheno-phases with simultaneous graphical representation in a special container is performed.



**Fig. 3.** The main window of the Feno-S program with the histogram form duration of phenophases.

To date, the phenological database has 5342 records by year (1999-2019) for 536 taxa representing 52 families and 108 genera.

Computer programs "BD-PLANT-KZ", "DInCeR", "PLANT-EST-KZ" and "Feno-S" have passed state registration in the Ministry of Justice of the Republic of Kazakhstan, are protected by appropriate protective documents and server versions of the database placed on the domain <https://dincer.kz/> are made for them.

Further improvement and introduction of computer programs in the practice of phyto-introduction and landscape gardening will greatly simplify the creation of information databases, will promptly search for taxa and expand opportunities to work with information about exotic species. This will reduce the cost of selecting the assortment for the creation of green devices of various functional purposes.

## References

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2. A. Takhtajan, Diversity and Classification of Flowering Plants (New York, Columbia University Press., 1997)
3. I. N. Safronova, Proceedings of the Botanical Institute named after V.L. Komarov RAS, **18** (1996)