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AdvenAlg, a software to help with the identification and a knowledge of the main crop weeds in Mediterranean Algeria

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ABSTRACT

Access to AdvenAlg is via the URL address: www.wikwio.org/alg/ which currently allows the identification of 125 important species of algerian weeds in field crops. They are divided according to their noxiousness into 15 agronomically major species, 20 secondary species, and 90 minor species. This modern computer-assisted identification (CAI) method allows simple and precise identification of plant species based on illustrated characters (and not described by botanical jargon as is the case with classic dichotomous keys), therefore in a graphic manner, by creating a composite portrait of the plant. Emphasis is placed on vegetative characters to enable recognition of incomplete samples. A composite portrait of the plant is created using a process allowing the free choice of characters, error management, the absence of technical terminology and self-correction. At any time, it is possible to access macro photographs and descriptive texts and print them. The AdvenAlg database, available in French or English, will be gradually updated with other species of crop weeds from the same phytogeographic region. All AdvenAlg species sheets can also be consulted on the Wiktrop collaborative portal dedicated to the sharing and dissemination of knowledge on weeds in tropical and Mediterranean crops: http://portal.wiktrop.org

1. Introduction

Weeds, or « … unwanted plants that grow where they have not been intentionally planted » (Okigbo, 1978) are very harmful to crops in developing countries. Identification of crop weeds is essential to get the information needed for elaborating efficient control methods. Non specialised people had difficulties to do this identification with classical tools, such as floras or field guides (too technical, unsuitable for seedlings or partial samples, process difficult to follow…). In all ways, weed scientists, who focus their research on weed biology, ecology and management are unfotunately not present in sufficient numbers. Moreover, weed identification by use of classical floras presents different constraints. Based on the Linnaean classification, they do not allow the identification of an incomplete sample (without flower) or from a young plant, stage at which the weed must be identified. They use technical terminology that is difficult for non-users to understand specialists and proceeds by dichotomous key which does not tolerate error, nor the absence of answer. In addition, these keys generally require entering a large number of characters before arriving at the answer.

The idea of using computer capabilities to identify plants emerged in the 1970s. There have been various classes of computer-based identification systems (such as expert systems, statistical classifiers and neural network (Webb, 1999; Ripley, 1996) but for botanists, electronic multi-access key types (e-keys) have predominated and are a natural progresssion from paper-based multi-access keys and especially punched hole cards. In this context Lucid was one of the leading e-key package designed both for authors and users (Dallwitz, 2000). Available e-keys work in a similar way, based on a matrix of characters (sometimes called 'features') by taxa in a database that can be sorted or queried in any order. A standard called DELTA (Description Language for Taoxonomy) exists for communicating between character databases. Some programmes allow users to score the characters for reliability, ease or interpretation, rarity, etc. (Lawrence and Hawthorne, 2006). The easiest characters can be considered before the more difficult. Other uncoded textual information and pictures may also be shown, and picture browsing is also more or less supported (Lawrence and Hawthorne, 2006).

The arrival of multimedia and the Internet has opened up new opportunities for building new types of tools. These interactive image-driven identification (e.g. : Le Bourgeois et al., 2008 ; Van Valkenbur et al., 2014) use identikit which allows the user to build the image of the plant from traits freely chosen according to the specimen or to the user and without prior knowledge of botany.

All of these systems combine the construction of a robot portrait of a plant and a calculation of similarity indices. Each time a new character is provided, the software calculates all of the similarity indices between each of the species and description made by the user on the robot portrait. This similarity index corresponds to the ratio between the sum of weighted character states common to portrait and the species considered and the amount weighted character states described in the robot portrait (Grard, 1996).

Our aim here is to present AdvenAlg 1.1 a software which helps weed identification in Algeria based on the construction of robot portrait of the desired plant. It uses only drawings and not any real botanical skills are needed. A probability of similarity is calculated for each species in the data base and the most likely weed species are listed in descending order of similarity.

2. Presentation of AdvenAlg 1.1

AdvenAlg 1.1 (Kazi Tani et al., 2021) highlight weed problems from a multidisciplinary perspective (Fig. 1). This software help agronomists and farmers, extension agents and researchers in identifying weeds while providing them with a more detailed understanding of growing conditions and promoting better control of noxious weeds and the agricultural environment. A printable modular field guide of AdvenAlg 1.1 has been published in the scientific review *Al Yasmina* (Kazi Tani et al., 2021) where species identification is based largely on browsing. We believe that books in addition to not needing technical support they are 'future proof' (Lawrence and Hawthorne, 2006). Book users need less trainning than computer users, especially if they are not confortable with computers. The layout of a book is globally well understood.

These two information tools were developed on the basis of several years study of weeds and agricultral system in the Oranian phytogeographic region (Kazi Tani, 2011). This region was chosen for high floristic Mediteranean diversity and the fact that the edaphic, bioclimatic and agronomic conditions are representative of the whole Algerian Mediterranean region.

Figure 1. The AdvenAlg logotype is inspired by the decorative symbolism of Berber pottery and tapestry

2.1. Different degrees of weeds noxiousness

The first version of AdvenAlg describes and helps users identify 125 of the most important weeds recorded in annual and perennial crops of Mediterranean Algeria (Kazi Tani et al., 2021) and both the adult stage and the seedling stage, their geographical distribution, their phenology, ecology, the control methods, and details of their uses as an agro-ecological indicator, as food or medicinal plant.

The described weeds are distributed according to their noxiousness into 15 agronomically major species because they are both frequent and abundant and responsible of significant yield losses; 20 secondary and ubiquitous species that are not considered a problem in the current phytotechnical context but that must be monitored due to their large distribution, any modifications of the agronomical context could result in a disruption in inter-specific competitive relationships, and some of these species can become major; and 90 minor species, restricted to very specific environments and are much less common and abundant (Kazi Tani et al., 2021).

For each species, the official Latin name is given along with the most comon synonyms and the international EPPO code (EPPO, 2008). There is a complete botanical description, which focuses on vegetative traits (30 groupes of vegetative traits in addition to 5 groups of sexual traits) to enable identification of incomplete samples. This is illustrated with colour photographs of adult plants, plantlets and specific in situ details. Each

plant's behaviour, biology, phenology, phytogeography, ecology in Mediteranean Algeria, and growth cycle are also detailed in online Html pages in both French and English. These descriptive files can be regularly updated on the Web site. Ecological aspects specifically concern the soil and bioclimatic conditions required for growth, and the effect of different cropping systems on the extent of infestation. The phenological cycle is described with respect to the cropping calendar, while highlighting the effects of machanical weeding.

2.2. AdvenAlg an attractive interactive system

Access to AdvenAlg software is at the following URL adress :

https://www.wikwio.org/alg/

In constrast to traditional approaches, this highly educational and fully illustrated interactive software provides easy and particularly lively access to flora.

The software includes a species identification module linked to the Wiktrop database: https://portal.wiktrop.org (Le Bourgeois et al., 2018). Weeds are identified graphically by building a profile portrait of the plant (Fig. 2).

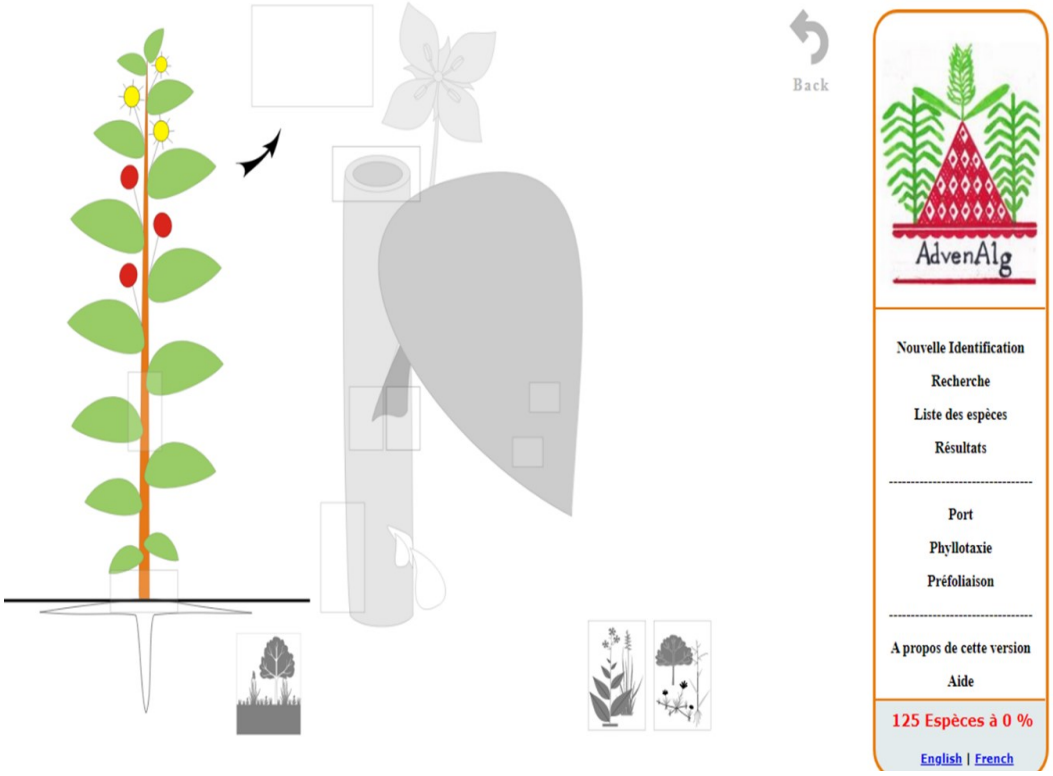

Figure 2. Profile-portrait identification.

This method has several advantages :

- it only involves drawings, with no botanical technical terminology. Image driven identification helps to avoid misunderstandings in botanical terminology ;
- the user chooses which traits to describe ;
- incomplete samples can also be identified, as missing information is tolerated, which is often the cause of failure in dichotomous classical keys. The flexibility of data display is undoubtedly a huge boon ;
- observation errors are also tolerated ;
- Modern students are generally comfortable with the 'point-and-click' browsing approach to information, and interactive software may draw some to weed science if the interference seems modern, regardless of the content or actual usability ;
- the AdvenAlg database will be gradually updated with other crop weed species from the same phytogeographic region (Fig. 3).

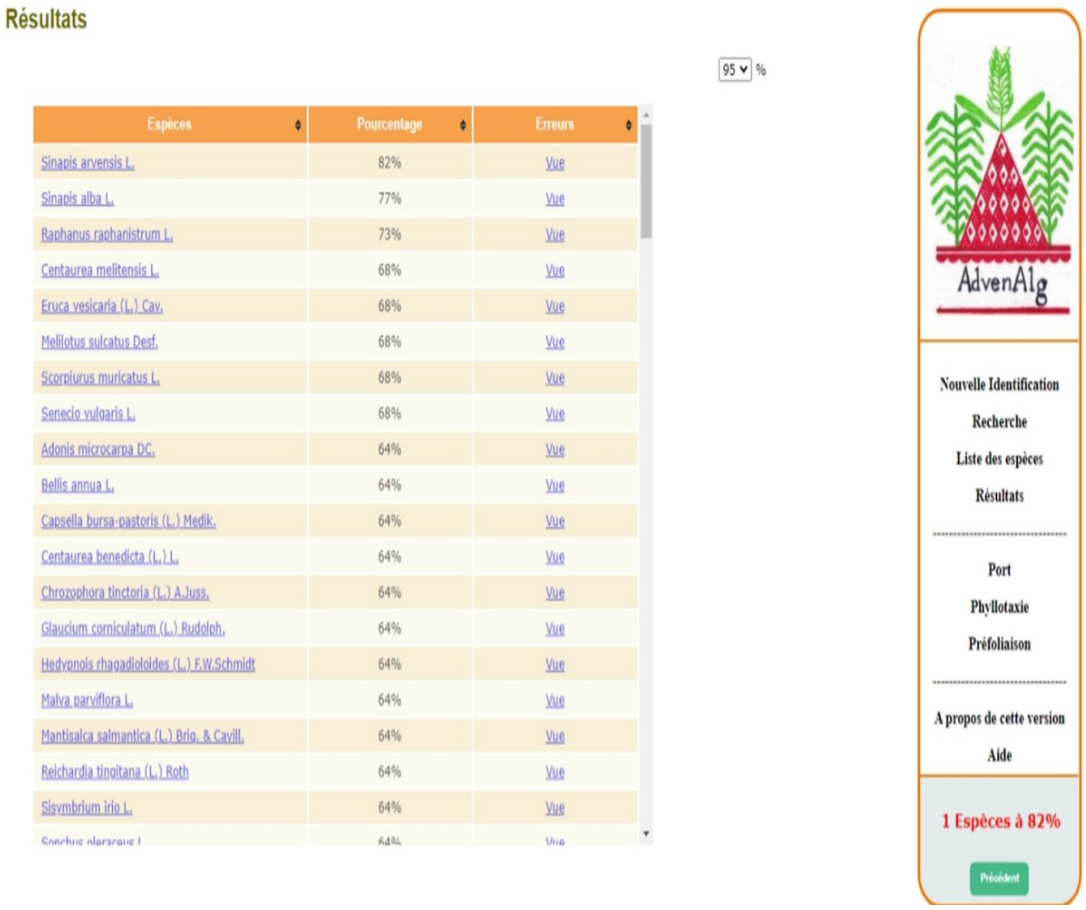

Figure 3. On clicking on results, species listed in descending order of similarity

The user has access to the colour photographs and descriptive texts at any times, and species pages can also be printed. When a species has been identified with a probability less tha 100%, the profile portrait highlights which traits are inadequately described (Fig. 4). No special computer skills are required to use AdvenAlg : an on-screen icon bar gives the user access to all options, which can be selected by simply clicking on the chosen icon button.

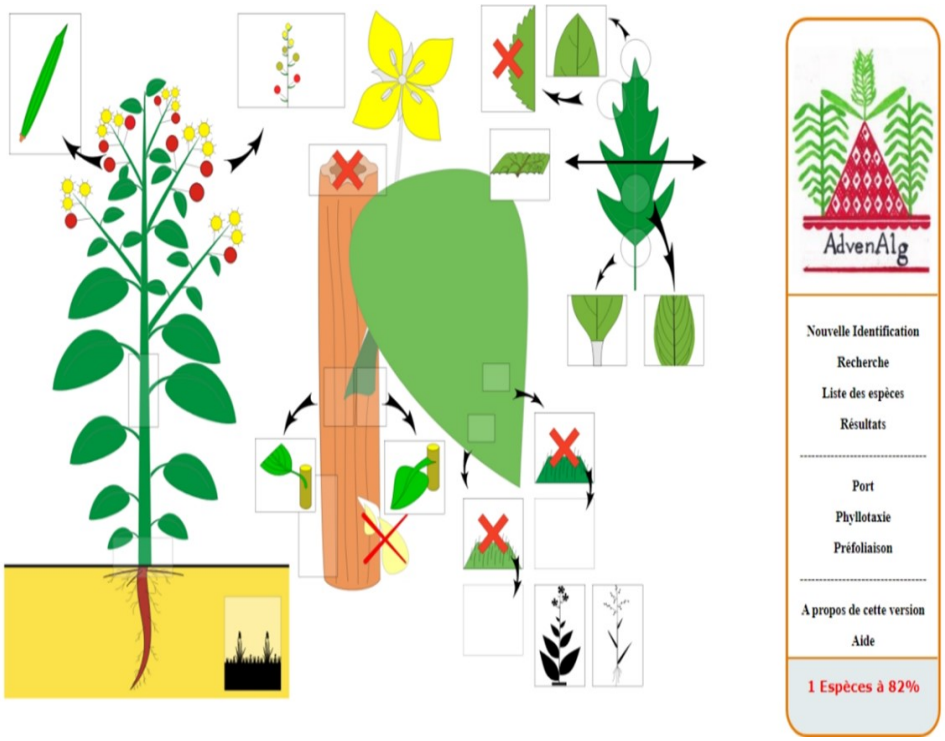

Figure 4. Identification of inadequately described traits (x)

All AdvenAlg species sheets can also be consulted on the Wiktrop collaborative portal dedicated to the sharing and dissemination of knowledge on weeds in tropical and Mediterranean area (Le Bourgeois et al., 2018). Wiktrop is a geographical extension of WIKWIO collaborative portal : https://wikwio.org/portal for weeds of tropical and mediterranean areas around the world.

The Wiktrop portal allow users to share technical and scientific documentation on weeds and their management. It also allows to share field observations of weeds, either to report the presence of a species in a given agroecological context, or to ask for help from the community to identify an unknown species. The Wiktrop portal is linked to the Wiktrop mobile application for Android, allowing users to collect and post weed observations. Available for free on Play Store.

4. Conclusion and prospects

AdvenAlg's fact sheet originally written in French includes an English version. This software is designed mainly for educational, research and development institutes, and represents an efficient research, extension and training tool. The information offered by this software should help in developing rational weed control practices that are adjusted to each specific situation. Indeed, users should gain a great deal of knowledge on the major weeds and conditions required for their growth. Some species are good indicators of fertility or degradation of the soil and cropping system. These so-called weeds could also become essential elements for understanding cropping system : « plants for which man has not yet found a use » (Anderson, 1977). This database will be progressively updated with the remaining 400 weed species from the Algerian Mediterranean region according to Quézel and Santa's Flora (Quézel and Santa, 1962-1963).

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