TUNWeeds: A Smart Identification Tool for Brassicaceae Weeds in Rapeseed (*Brassica napus*) Crop in Tunisia

El-Waer Nour El-Houda, Département des Sciences Biologiques et de la Protection des Végétaux, ISA Chott-Mariem, Université de Sousse, 4042 Chott-Mariem, Sousse, Tunisia, **Medimagh Sana**, LR/Grandes Cultures, INRAT, Université de Carthage, Rue Hédi Karray, 1004 Tunis-Menzah, Tunisia**, Mekki Mounir**, Département des Sciences Biologiques et de la Protection des Végétaux, ISA Chott-Mariem, Université de Sousse, 4042 Chott-Mariem, Sousse, Tunisia**, and El-Waer Saifeddine**, INSAT, Université de Carthage, Centre Urbain Nord, Tunis Cedex 108, Tunisia

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ABSTRACT

El-Waer, N.E-H., Medimagh, S. Mekki, M., and El-Waer, S. 2018. TUNWeeds: A smart identification tool for Tunisian Brassicaceae weeds in rapeseed (*Brassica napus*) crop. Tunisian Journal of Plant Protection 13 (si): 191-198.

Rapeseed is the second oilseed in the world. Its cultivation requires successful weed control. Weed identification is critical in weed management programs. Two surveys of common weeds in rapeseed fields allowed us to identify a wide specific diversity of weed flora and a great identification difficulty of certain specimens. To facilitate this task, we have developed a web application (TUNWeeds) for Tunisian farmers and students. At first, we limited our database to 44 Brassicaceae weeds. Subsequently, we plan to extend this application to other botanical families. TUNWeeds can help farmers in chemical weed control, manage herbicide resistance problems, and monitor weed flora.

Keywords: Brassicaceae, identification, web application, weed flora
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The production of vegetable oils (excluding olive) in Tunisia is a national concern. Rapeseed, the second oilseed in the world, has the advantage of diversifying field rotations; it improves yields of cereal crops and minimizes several phytosanitary problems (Ben Salah 2008). The Tunisian experience in the production and processing of oilseed rape dates back to the 1980s. However, according to the Tunisian Ministry of Agriculture, its acreage in 2016 is about 1400 ha.

Successful weed control in rapeseed crop is crucial. Weed identification is critical for successful weed management programs. Traditional weed identification tools present difficulties for farmers and technicians (too technical and inefficient for juvenile specimens). New computer tools for weed identification allow users to freely choose identification characters based on the specimen or user and tolerate user's observation errors. These tools can be used with PC, Tablets, or Smartphones off line or on line. They are easily updatable and extensible (illustrations, additional information, etc.) (Grard et al. 2012).

The main goal of our graduation project was to conceive a smart weed identification tool for farmers and students to improve weed management. Our specific objectives were: (i) to assess the difficulties of the conventional tools of weed identification and (ii) to design a smart tool to facilitate identification of Brassicaceae weeds.

MATERIALS AND METHODS

Weed scooting in rapeseed was carried out at two geographical locations (OTD-Borj Essebeii-Mateur and Smenja-Zaghouan), view the lack of time and the huge workload. At each location, we conducted two floristic samplings at 02-03 March 2017 and 06-10 May 2017. The weeds were identified using the printed flora of Pottier-Alapetite (1979) and Lenten catalog (1990).

The main reference used for compiling our database was the flora of Pottier-Alapetite (1979). Updating of species nomenclature has been done according to Dobignard and Chatelain (2011). The List of Brassicaceae weeds was based on national and international bibliographic references (Jauzein 1995; Lent 1990; Stephen 2003; Taleb et al. 1998; Tanji 2005). The database gathers in a well-structured way all the data needed for fast and reliable identification of 44 Brassicaceae weeds. It includes:
- Species nomenclature: official scientific names (Jauzein 1995; Lent 1990; Stephen 2003; Taleb et al. 1998; Tanji 2005), EPPO codes, Synonyms, and Common names.
- Species descriptors of whole plants and their main organs (leaves, flowers and fruits) as described by Pottier-Alapetite (1979).
- Species sheets including detailed information on each taxon.

- Glossary of botanical terms (Boullard 1988; Danjon et al. 2007; Douzet 2007; Gadrat2003; Reille 2012, 2013; Thebault 2017).

TUNWeeds is designed as a website requiring perfect mastery of several coding languages such as PHP, HTML, CSS, and Javascript.

RESULTS

The weed flora in rapeseed crop revealed a great weed species diversity, depending on locations and sampling dates (Table 1). Weed identification owing to the printed flora of Pottier-Alapetite (1979) revealed major difficulties with several specimens, especially at the first sampling date.

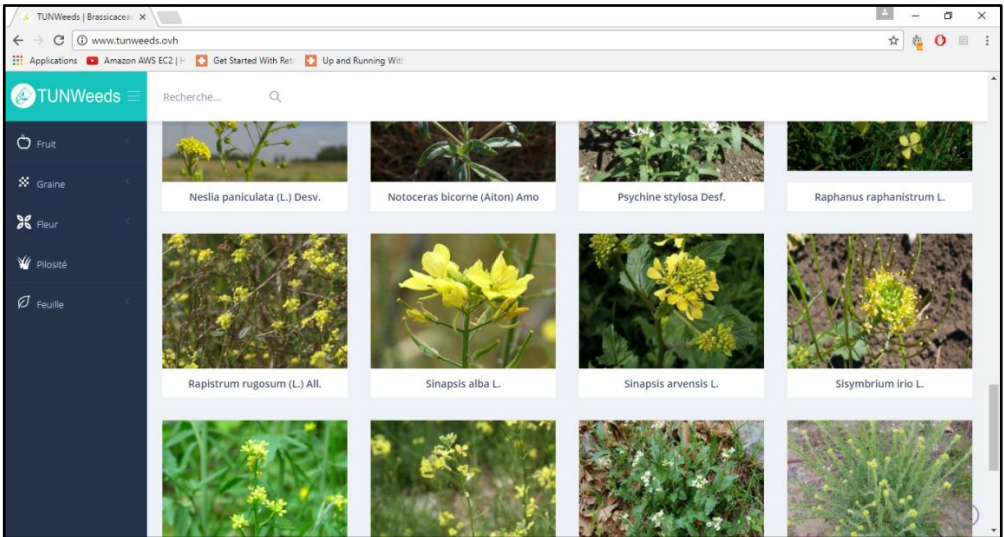TUNWeeds home page offers three possibilities for weed specimen identification (Fig.1):
(i) Search by name (scientific or common) of a species to access to its information sheet (Fig. 2);
(ii) Search by displayed images to access to the information sheet of the selected species; and
(iii) Search with the engine by answering simple questions about the descriptors of the specimen to be identified (Figs. 3 and 4).

DISCUSSION

Weed control is a major challenge for sustainable development of agriculture. It requires easy and reliable identification of weed flora in order to monitor its dynamic and favor ecological management of the most noxious species. Correctly identifying, major weeds is an important step toward effective weed control but identifying weeds on a farm is not easy.

Table 1. Weed flora in rapeseed at two Tunisian locations during two sampling dates

| Location	Location 1 : Mateur		Location 2 : Zaghouan	
Sampling date (2017)	March 02	May 10	March 03	May 06
Taxa count	14	25	29	33
Families count	7	11	14	11
Most abundant weeds				
Arum italicum	x			
Lolium rigidum	x		x	x
Medicago ciliaris	x			
Glebionis coronaria	x		x	
Sonchusa rvensis		x		
Fumaria parviflora		x		
Anagallis arvensis		x		
Diplotaxis erucoides		x		
Papaver hybridum			x	x
Papaver rhoeas			x	
Avena sterilis				x
Bupleurum lancifolium				x
Unidentified taxa	5 (36%)	4 (16%)	2 (7%)	4 (12%)
Brassicaceae taxa frequency (%)	14	20	10	10

Fig. 1. TUNweeds homepage: three recognition possibilities: (i) Name of a species, (ii) Selection of an image from the displayed list and (iii) Web engine.
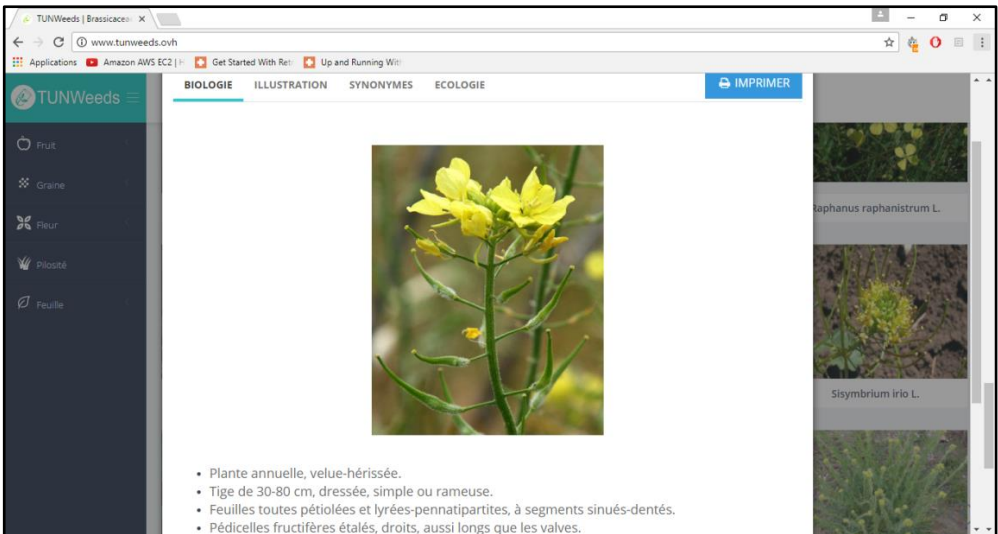
Fig. 2. Species information sheet including detailed information on each taxon: (i) Biology, (ii) illustrations, (iii) Synonyms, and (iv) Ecology.
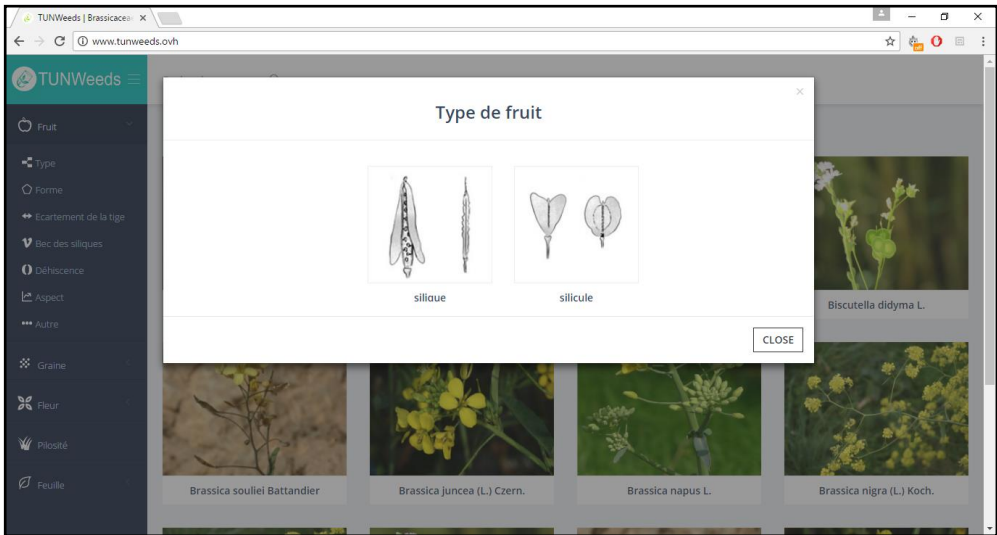
Fig. 3. Search with the web engine: e.g. fruit type.
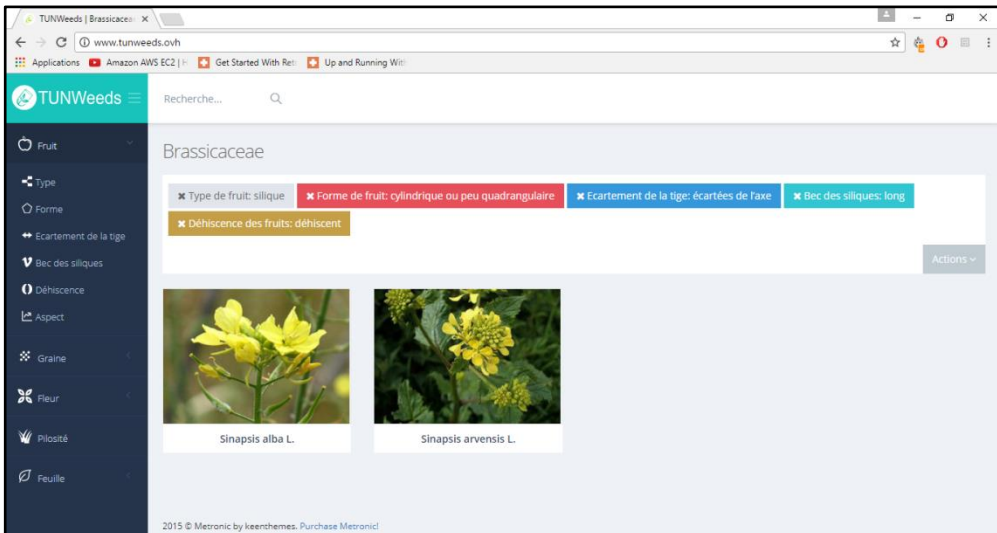
Fig. 4. Output of a search with five descriptors.

Conventional weed identification is based on field guides, manuals, or dichotomous keys. The grower should collect and examine representative specimens. Therefore, he should be familiar with the jargon used in field guides or keys. Plants are identified by visible characteristics but several characteristics are variable. Flowering specimens are easiest to identify to the species level. However, growers often want to identify major weeds in earlier growth stages. A dichotomous key gradually narrows possibilities down to one or a few species. However, an interactive key, usually available on line or on a computer CD-ROM, allows you to start with the most readily observable characteristics of the specimen at hand. It is usually better than the dichotomous key for identifying a weed in a vegetative (non-flowering) stage of development. Several weed scientists have developed interactive keys, based on computer databases that catalogue main agricultural weeds.

TUNweeds is a web application dedicated to the identification and management of weeds and invasive alien plants in Tunisia. A pilot project has been carried out to identify 44 weeds of the family Brassicaceae (Table 2) and we plan to continue the development of this application and extend it to other botanical families.

Table 2. List of TUNweeds' 44Brassicaceae weeds

Scientific names of the Brassicaceae taxa within the TUNweeds	
Arabidopsis thaliana	*Hirschfeldia incana*
Barbarea vulgaris	*Hornungia petraea*
Biscutella auriculata	*Iberiso dorata*
Biscutella didyma	*Lepidium sativum*
Brassica souliei	*Lobularia libyca*
Brassica juncea	*Lobularia maritima*
Brassica napus	*Malcolmia africana*
Brassica nigra	*Matthiola parviflora*
Brassica rapa subsp. *sylvestris*	*Moricandia arvensis*
Brassica tournefortii	*Neslia paniculata*
Bunias erucago	*Notoceras bicorne*
Camelina sativa	*Psychi nestylosa*
Capsella bursa-pastoris	*Raphanu sraphanistrum*
Cardamine hirsute	*Rapistrum rugosum*
Cardaria draba	*Sinapsis alba*
Clypeo lejonthlaspi	*Sinapsis arvensis*
Conringia orientalis	*Sisymbrium irio*
Lepidium didymum	*Sisymbrium officinale*
Lepidium squamatum	*Sisymbrium orientale*
Diplotaxis erucoides(	*Sisymbrium polyceratium*
Diplotaxis muralis	*Sisymbrium runcinatum*
Eruca vesicaria	*Teesdalia coronopifolia*

RESUME

El-Waer N.E-H., Medimagh S., Mekki M. et El-Waer S. 2018. TUNWeeds: Un outil didactique d'identification des adventices *Brassicaceae* de la culture du colza (*Brassica napus*) en Tunisie. Tunisian Journal of Plant Protection 13 (si): 191-198.

Le colza est la deuxième graine oléagineuse la plus produite dans le monde. Son introduction en Tunisie nécessite une bonne maîtrise de son désherbage. Des relevés floristiques de la flore adventice de cette culture à deux sites tunisiens nous a permis de constater une large diversité des adventices et une difficulté de les identifier. Pour cette raison et afin de mieux gérer le désherbage, une application web (TUNWeeds) est conçue et développée dans l'objectif de faciliter cette identification par les agriculteurs. TUNWeeds peut aider les agriculteurs à mieux raisonner le désherbage chimique de leurs cultures, gérer les problèmes de résistance des plantes indésirables aux herbicides, et surveiller la dynamique de la flore adventice. Cette application informatique peut servir comme outil didactique de reconnaissance des adventices pour les étudiants, les techniciens et les agriculteurs. Dans un premier temps, TUNweeds s'est limitée à la reconnaissance des adventices de la famille des *Brassicaceae*. Ultérieurement, nous envisageons d'étendre cette application à d'autres familles botaniques et de la développer pour les Smartphones.

Mots clés: Application web, *Brassicaceae*, flore adventice, identification

ملخص

الواعر، نور الهدى وسناء مديمغ ومنير المكي وسيف الدين الواعر. 2018. "TUNWeeds": أداة توجيهية لتشخيص الأعشاب الضارة من فصيلة الكرنبيات في زراعة السلجم في تونس.
Tunisian Journal of Plant Protection 13 (si): 191-198.

تعتبر حبوب السلجم ثاني أهم الحبوب الزيتية إنتاجا في العالم، وعملية إدراج زراعة السلجم في تونس تتطلب قدرة فائقة على التحكم في الأعشاب غير المرغوب فيها بهذه الزراعة. مكنتنا المتابعة المتواصلة لهذه الأعشاب في موقعيْن لزراعة السلجم من إدراك تنوع كبير في أصناف الأعشاب الضارة المتواجدة بهما مع صعوبة في التشخيص. لهذه الأسباب وسعيا إلى إدارة أفضل لهذه الأعشاب الضارة داخل المزارع قمنا بإعداد تطبيقة واب تحت تسمية "TUNWeeds" قادرة على تبسيط طريقة التشخيص لدى الفلاحين. تساعد هذه التطبيقة الفلاح على ترشيد المكافحة الكيميائية لمزارعهم وإدارة مشاكل مقاومة الأعشاب غير المرغوب فيها بالمبيدات العشبية كما تسهل مراقبة ديناميكية الفلورا الضارة. يمكن استعمال هذه التطبيقة كأداة توجيهية لتشخيص الأعشاب الضارة من طرف الطلبة والتقنيين والفلاّحين. كبداية، اقتصرنا على الأعشاب الضارة لفصيلة الكرنبيات. مستقبلا، سنعمل على توسيع هذه التطبيقة لتضم فصائل نباتية أخرى وعلى تطوير استعمالها على الهواتف الذكية.

كلمات مفتاحية: تشخيص، تطبيقة واب، فلورا ضارة، كرنبيات

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