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Morphotype diversity of *Corchorus olitorius* and influence of agricultural practices on its potential major pest insects

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ABSTRACT

Corchorus olitorius L. is one of the traditional leafy vegetables of high food and socio-economic value in Africa. Although widely exploited, its varietal diversity is unknown and its domestication remains challenged by pests and diseases presently observed among subsistence users. This study aims to determine the morphotype diversity of *C. olitorius* in Southern Benin and the durability of its agroecosystem by the influence of agricultural practices on the major pest insects related to its production. Using participatory research methods, surveys were conducted in 21 villages randomly selected across the study area. Results revealed seven different morphotypes of *C. olitorius*, three of which were wild but used in traditional medicine and four were cultivated. Among the nine constraints reported by farmers, the attack of seven pest insects and the non-distinction of the seeds of the different cultivated morphotypes are the two most important constraints. The seven most common potential pest insects observed by between 10–100% of the farmers, in study area are: *Acrea* sp, *Aulacophora Africana, Helicoverpa armigera*, *Spodoptera litoralis, Zonocerus variegatus, Podagrica* spp. and *Acrea acerata.* The infestation by these insects were not linked to specific morphotypes of *C. olitorius*, but varied by locality. The agricultural practices that might influence the presence of any *C. olitorius* pests were intercropping and dormancy cutting, seedling after sowing and number of harvests. This information will contribute to a better production of the varieties of *C. olitorius* and the different crop associations could be integrated into methods of ecological management of the pests of *C. olitorius*.

1. Introduction

Traditional leafy vegetables play an important role in the diets of populations of the world by assuring them the essential part of their nutritional and medicinal needs (Dansi et al., 2011; Odhav et al., 2007; Uusiku et al., 2010). Their content of iron, vitamins A and C corresponds to health benefits particularly significant in countries where there are many cases of anemia caused by iron deficiency, and to counter the effects of malaria, and immune deficiency (Ndlovu and Afolayan, 2008; Ojiewo et al., 2013). The presence of high carotenoids rate in most African leafy vegetables would confer antioxidant properties favorable to human health (Oboh et al., 2009). Thus there has been a recent focus on the domestication breeding and production of traditional vegetables especially in peri-urban environments. Monocultural production of these vegetables in irrigated year-round systems may lead to new challenges associated with the cropping characteristics of the available varieties, product quality under intensive management and ability to withstand persistent defoliation associated with commercial production. Similarly consumer preferred qualities and post-harvest novel pest challenge and pest resistance may become new issues to pursue. Most significantly, the possibility of emergence of new pests of recently domesticated crops is a phenomenon that is difficult to predict, although some of the eventual pests might be among pests and pathogens already using these and closely related species for survival. Many traditional leafy vegetables exist as semi cultivated species, so, enable humans to exploit uncultivated environments or crop land off season. This increases the nutritional returns and mineral cycling in the environment.

Corchorus olitorius is one such vegetable. Commonly known as "Jew's mallow", "tossa jute", "bush okra", "krinkrin", "molokhia", "West African sorrel" and "jute mallow", it is rich in minerals, vitamins and other nutritional factors (Bailey, 2003). This is one of the most widely

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consumed traditional vegetables in Africa (Ngomuo et al., 2017a,b) and is also consumed in Asia (Kar et al., 2009). Obtained from both cultivated and wild sources, it is rich in vitamins, mineral salts and folic acid, constituting an important nutritional contribution (Zeghichi et al., 2003). The leaves are consumed as a component of vegetable based dish that accompany starchy dishes. It may be prepared alone or in mixtures with legume leaves (East Africa) or other wild vegetables or in mixture enriched with fish sauce. Thus, it could play an extremely important role in food security and the fight against poverty in Africa (Attere, 1999).

Although *C. olitorius* is widely used in Asia and Africa and despite its socio-economic and nutritional importance, several constraints are linked to the development of the plant in the wild or cultivated. Previous studies have focused on the agromorphological and genetic evaluation of accessions towards boosting a breeding programme (Kiebre, 2016) on the agromorphological evaluation of *C. olitorius* accessions respectively in Burkina Faso and Ivory Coast. Others studies were on morphotype diversity (Akoroda, 1985); seed production in Nigeria (Akoroda and Akintobi, 1983); domestication, ethnobotany and production constraints in Ghana (Nyadanu et al., 2017). Being a plant in the process of domestication, its genetic diversity is little studied, meaning the existing studies may not be applied across the diverse ecological range of this vegetable. Similarly, most of these studies do not address the diversity and the potential impacts of insect pests that feeding off this plant in the wild and cultivated environments. Due to the fact that the plant is harvested from the wild and consumed, economic thresholds are tough to determine. Pests are potential threats to wider cultivation and efforts must be made to adapt varieties to them. At the same time, farmers suffer a decline in selling prices because of the low level of purchasing power of consumers (Adégbola and Singbo, 2001).

This study therefore investigated the morphological diversity of wild and cultivated *C. olitorius* existing in South Benin, as a basis for documenting desired characteristics and comparing potential diverse populations exploited. We also documented the potential pests affecting the crop, their prevalence and the farmer's knowledge of these pests, their symptoms and damage levels. Finally we investigated the link between the potential pests and crop management practices. Specifically, the aim was to: (i) make an inventory of the different morphotypes of *C. olitorius* in southern Benin; (ii) rank varietal preferences criteria and crop constraints of different morphotypes of *C. olitorius* in southern Benin; (iii) identify the key potential insect pests associated to the production and (iv) determine the influence of agricultural practices on the presence of major insect pests.

2. Material and methods

2.1. Study site

The study was carried out in 5 districts of Southern Benin, namely the Atlantic, Oueme, Plateau, Mono and Couffo. These districts are located in the Guineo-Congolese agroecological zone. It is subdivided into four phytogeographic districts: Costal zone, Pobe, Oueme Valley and Plateau (Adomou et al., 2006). It is characterized by two dry seasons that alternate with two rainy seasons with an annual average precipitation ranging from 1100 to 1400 mm/year (Yabi and Afouda, 2012). The study area is characterized by a subequatorial climate, marked by high but not excessive temperatures that revolve meanly around 27.5 °C per day. The average relative humidity is 80% per day. For the geomorphology, the Southern Benin region includes the low altitude coastal zone, including sandy soils of various ages, lagoons and swamps.

2.2. Farmers selection and participatory surveys on production constraints and preference criteria of C. olitorius

Twenty-one (21) villages were randomly selected for the survey across the five districts. The choice of these villages was initially made through documentary research in particular based on the study of Alissou (2011). We first identified three villages producing *C. olitorius* in the Mono-Couffo districts. It was once in these three villages that farmers informed us on other villages where *C. olitorius* is cultivated. The data were collected in the various villages during August to September 2016 through the use of tools and methods of participatory research approach, such as direct observation, group discussions, individual interviews and field visits (Kombo et al., 2012; Dansi et al., 2013; Dossou-Aminon et al., 2014). Information on the locality (district name, village name, ethnic group) was first documented after a detailed presentation of the research objectives to the authorities and farmers. Farmers were then asked to cite in vernacular names the different morphotypes of *C. olitorius* produced in their villages and identified on the basis of 6 morphological parameters: leaf size, margin form, leaf, stem, ribs and ligules. Discussions with farmers, different morphotypes produced, their morphological descriptions, their vernacular nomenclatures as well as the constraints linked to their production have been documented. The constraints were classified according to Dansi et al. (2013) by identifying and eliminating the most severe. The agronomic, economic and culinary performance of identified *C. olitorius* morphotypes were also documented using the spontaneous reaction evaluation method. For each parameter studied, morphotypes are evaluated farmer by farmer using 2 scores: 0 and 1. Score 1 is assigned when the performance of the morphotype is recognized by the farmer for the parameter considered. If not, the score is 0.

2.3. Determination of agricultural practices and major potential insect pests of C. olitorius

Information on agricultural practices was collected on the types of associated crops, seeds dormancy emergence, date of seeds lift after seeding, duration between seedling and harvest, number and date of harvest, the types of fertilizers and pesticides used by the farmers. During the visits to the *C. olitorius* production sites, insects and their damages were observed directly on the crops and recorded (or documented). Initially, they were asked to identify on a sheet the pest insects of *C. olitorius*. On this sheet, we put the photos of all the pest insects revealed by the documentary research. Farmers are individually then invited to list the other insects that attack their plants of *C. olitorius* and which are neither observed directly nor represented in image on the previous sheet. Then, the damages were observed directly on plants and noted in percentage. Insect pests known by farmers were collected and identified in our entomology Unit of laboratory BIORAVE of National University of Sciences, Technologies, Engineering and Mathematics (UNSTIM – Benin).

2.4. Data analyses

Correspondence Factorial Analysis (AFC) was carried out to determine the relationship between the localities of production of *C. olitorius* and the morphotypes of *C. olitorius* grown on the one hand and the presence of the main pests of *C. olitorius* on the other hand. The same AFC was carried out to determine the relationship between the crop associations with *C. olitorius* and the presence of the major insect pests. Analyses of Variances (ANOVA) of the Generalized Linear Model (GLM) distribution and logit link with the binomial family were carried out to determine the effects of agricultural practices and types of crop associations on the presence of the major insect pests of *C. olitorius*. All the analyses were carried out in R (R Developer Core Team 2014) at the significant level of 5%.