Biomass and Bioenergy 91 (2016) 10–16

Contents lists available at ScienceDirect

Biomass and Bioenergy

journal homepage: http://www.elsevier.com/locate/biombioe

Research paper

Genetic variation and genotype by environment interaction in *Jatropha curcas* L. germplasm evaluated in different environments of Cameroon

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ARTICLE INFO

Article history:
Received 12 November 2015
Received in revised form
25 April 2016
Accepted 26 April 2016

Keywords:
Jatropha
Genetic variation
Genotype by environment interaction
Agronomic and quality traits
Breeding
Cameroon

ABSTRACT

Jatropha curcas L. (jatropha) is a perennial plant with a high untapped potential towards sustainable production of food and bioenergy. The transformation of jatropha into a competitive crop requires intensive breeding efforts. The objectives of our study were to (i) assess genetic variation of agronomic and quality traits in different environments, (ii) investigate genotype by environment interactions, and (iii) discuss potential selection strategies. Agronomic and quality traits were assessed on 277 jatropha genotypes that were evaluated over three environments in Cameroon. Genetic variation and heritability of agronomic and quality traits showed excellent prospects to select and breed improved cultivars rapidly. Selection for accumulated seed yield over years seems to be the best choice to increase annual seed and oil yield. Seed yield per month might be incorporated in selection indices to improve the efficiency of fruit harvesting. Selection based on a single testing environment was always inferior to the selection based on multiple environments. The magnitude of genotype by environment interaction (GxE) in jatropha is large. Therefore, testing in multiple environments is a requirement to select improved cultivars with local and broad adaptation.

1. Introduction

Jatropha curcas L. (jatropha) is a perennial plant of the Euphorbiaceae family [1]. This plant has a high untapped potential towards sustainable production of food and bioenergy [2]. Jatropha possesses an extraordinary ability to survive in hot and dry arid regions and its cultivation can recover degraded soils [3]. For these reasons, jatropha is targeted to be cultivated in marginal environments (land that is unsuitable for crop cultivation) [4]. In addition to biomass production and rehabilitation of degraded soils, a large amount of atmospheric carbon can be fixed [5]. The transformation of jatropha into a competitive crop requires intensive breeding efforts [6].

Plant growth and development are influenced by the genetic composition of the plant (G), the environment (E), and the interaction between them (GxE) [7]. To produce improved cultivars for multiple environments, GxE should be assessed in plant breeding programs. For the breeder, it is important to identify environmental regions where cross-over interactions do not occur (this secures the consistency in cultivar performance within the environmental region) [8]. Besides, evaluating the extent of GxE is of great interest for breeders to assess how much of the selection progress achieved in one environment can be carried over to other environments [9].

Assessment of jatropha genotypes in multiple environments started recently [6]. High heritabilities and large genetic variation for seed yield and quality traits were reported in this comprehensive multi-location assessment of jatropha germplasm. Although GxE was significant in the whole panel of genotypes evaluated over a gradient of climate, soil and agronomic management, some genotypes showed consistently superior performance across environments.

Cameroon has an enormous potential to cultivate jatropha [10]. Particularly in the Northern Province, neighboring the Sahel region, jatropha can contribute to conserve water, protect against soil erosion and stop desertification [11]. In Cameroon, jatropha is commonly grown as living fence and used as multipurpose medicinal plant [12] or for hygienic purposes [13] in rural areas. Research institutes testing germplasm on field sites could not yet

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http://dx.doi.org/10.1016/j.biombioe.2016.04.017
0961-9534/

identify genotypes that are adapted to the prevailing edapho-climatic conditions being economically competitive [10].

Cameroon possesses a large climate gradient from North to South (Fig. 1). It covers dry and hot climates in the sudano-sahelian zone to humid climates in the rainforest of the Congo basin [8]. This climatic gradient is a suitable option for the assessment of GxE in jatropha germplasm. The objectives of this study were to (i) assess the genetic variation of agronomic and quality traits in three different environments of Cameroon, (ii) investigate genotype by environment interactions, and (iii) discuss potential selection strategies.

2. Materials and methods

2.1. Climate and soil

The experimental sites (Batchenga, Ngaoundal, Garoua) have different characteristics of climate and soil (Tables S1 and S2, Figs. 1 and 2).

2.2. Plant material, experimental design and agronomic management

Seeds of 277 jatropha genotypes from various geographic origins were collected between 2008 and 2010 (Table S3). A study of the genetic diversity of the genotypes revealed a high level of

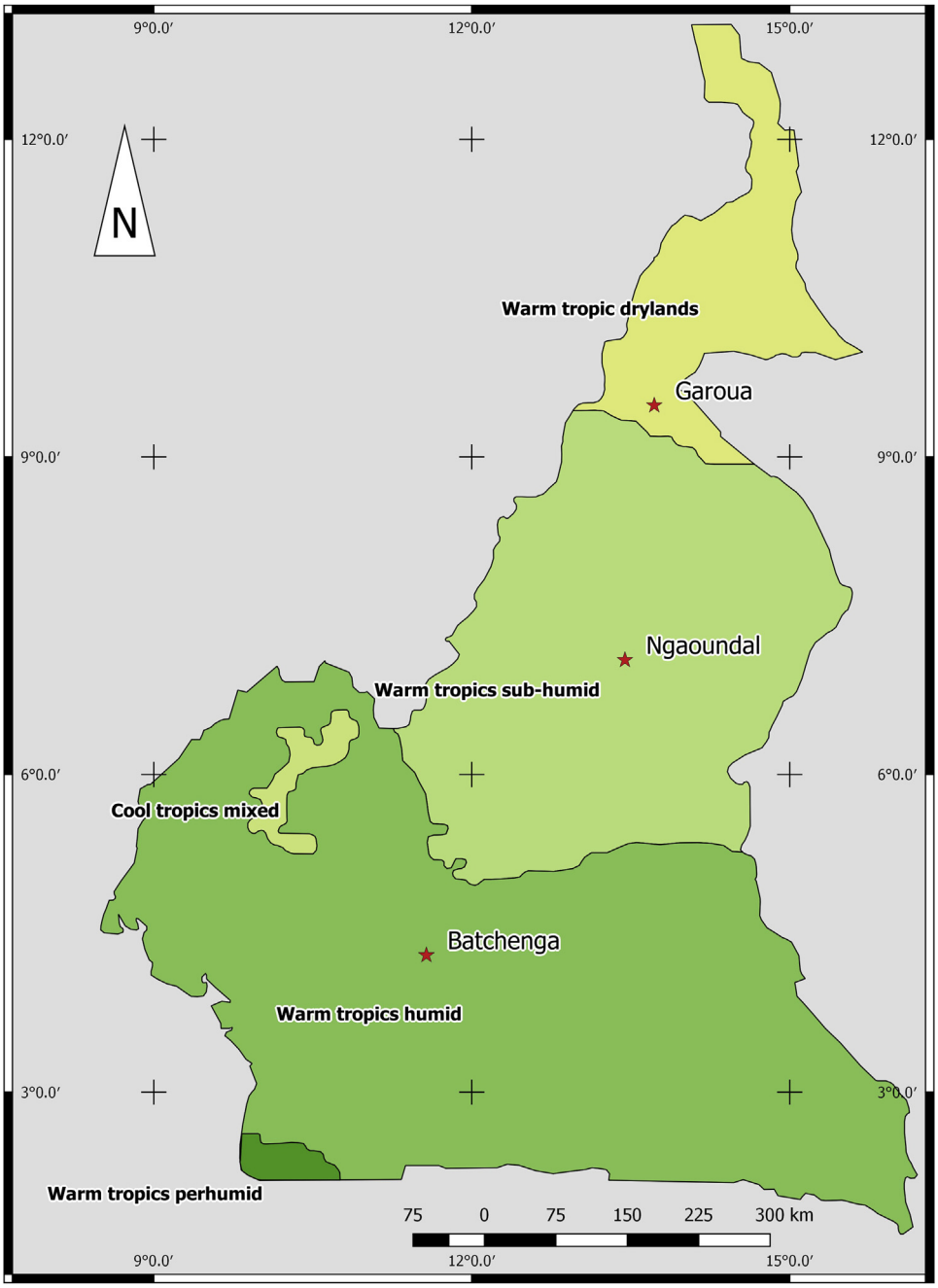

Fig. 1. Geographical position of testing locations in three different climatic regions of Cameroon.