THE CROP JOURNAL 4 (2016) 61–67

HOSTED BY

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Genotypic variation for seed protein and mineral content among post-rainy season-grown sorghum genotypes

Ashok Badigannavar[a,*], *G. Girish*[b], *V. Ramachandran*[a], *T.R. Ganapathi*[a]

[a]*Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai 400085, India*
[b]*Agricultural Research Station, University of Agriculture Sciences, Gulbarga 585101, Karnataka, India*

ARTICLE INFO

Article history:
Received 26 May 2015
Received in revised form 14 July 2015
Accepted 6 August 2015
Available online 16 August 2015

Keywords:
Mineral content
Post-rainy sorghum
Genetic correlation
Cluster analysis

ABSTRACT

Sorghum is an important staple food crop of Asian and African countries. As a "poor man's crop", it provides dietary starch, protein, and some vitamins and minerals. Minerals are important for various physiological functions in the human body. As a major staple crop of central and southern Indian provinces, sorghum landraces are a source of supplementary micronutrients. Concentrations of micronutrients and protein and yield parameters were studied using 112 local landraces and varieties. Univariate analysis revealed wide variation for iron (1.10–9.54 mg 100 g^{-1}), zinc (1.12–7.58 mg 100 g^{-1}), protein (3.50–12.60%), and grain yield (2.50–76.50 g) among the landraces. High estimates of genetic/phenotypic coefficient of variation, and genetic advances over the mean were identified for landraces and varieties. High heritabilities were also identified for yield and mineral content. Correlation estimates among the genotypes indicated that grain yield was positively correlated with copper and protein with copper and zinc. Cluster analysis based on Euclidean distance resolved all of the genotypes into three major clusters. The wide range of values with high heritability estimates may favor the use of these landraces in recombination breeding to improve nutritional quality in sorghum.

© 2015 Crop Science Society of China and Institute of Crop Science, CAAS. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Sorghum is an important cereal crop grown in India under rainfed conditions and in stress-prone areas. Globally, sorghum covers an area of 42.2 Mha with grain production of 62.3 Mt and productivity of 1.5 tons ha^{-1} [1]. Improved cultivars coupled with good management practices have increased productivity levels significantly despite decreasing acreage. In India, sorghum is grown on 6.2 Mha, accounting for 14.63% of the global area, with a production estimate of 5.3 Mt [1,2].

* *Corresponding author*. Tel.: +91 22 25590543; fax: +91 22 25505151.
E-mail address: ashokmb1@gmail.com (A. Badigannavar).
Peer review under responsibility of Crop Science Society of China and Institute of Crop Science, CAAS.

http://dx.doi.org/10.1016/j.cj.2015.07.002
2214-5141/© 2015 Crop Science Society of China and Institute of Crop Science, CAAS. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

The major factors responsible for the decline in area and production are a shift towards commercial crops such as groundnut, soybean, sunflower, and maize, and the availability of other cereals at reduced prices. In India, sorghum is grown in both rainy and post-rainy seasons, on shallow, medium, and deep soils. Although rainy-season sorghum has greater grain yield than that grown in the post-rainy season, most of it is used for industrial purposes. Post-rainy season sorghum is known for its grain quality and is cultivated mostly by marginal farmers for human consumption.

Sorghum is a good source of energy, protein, carbohydrate, vitamins and minerals. The grain contains 1.30–3.30% of ash and minerals such as phosphorus, potassium and magnesium in varying amounts. It is also an important source of iron (Fe) and zinc (Zn) and better than rice and wheat with respect to mineral nutrition [3]. Protein constitutes 12% of the grain on a dry-weight basis. There is substantial variation in total protein and amino acid profiles between sorghum varieties [4]. This variation may be attributed to the diverse range of agroclimatic conditions under which the crop is cultivated [5].

The poor digestibility of sorghum proteins is a major constraint to better utilization of the crop. It is due to the presence of antinutritive factors, including phytate, polyphenols, and kafirins [6,7]. Deficiencies in iron and zinc result in poor growth of children, reduced immunity, weakness, and morbidity [8]. Non-diversification of cereal and plant-based diets poor in micronutrients may be the major reason for micronutrient deficiency in the underdeveloped countries [9]. Dietary diversification, supplementation, fortification, and biofortification of crop plants are means of combating micronutrient malnutrition. Most of these approaches suffer from problems, but biofortification has been found to be the best way of increasing micronutrient content [10]. By this method, the bioavailability of minerals is improved by changing the genetic constitutions of food crops. Studies have even improved mineral bioavailability by reducing antinutritive properties or by soaking and germination [11]

Studies have been conducted to estimate macro- and micronutrient contents in yellow, black, and red sorghum genotypes. Studies have also been performed to reduce anti-nutritional factors and compare the effects of different physical and chemical seed treatment methods on the bioavailability of mineral nutrients. In one such study, advanced breeding lines and germplasm accessions showed higher values for Fe and Zn than popular varieties [12]. The range of Fe content was 12.10–83.40 mg kg^{-1} and that of Zn content was 6.30–51.40 mg kg^{-1}. Preliminary study of sorghum advanced breeding lines and a few selected germplasm accessions have indicated limited variation for grain Fe and Zn contents [13].

Identifying germplasm lines with improved yield and grain quality, especially with respect to mineral content, is an important task against the backdrop of malnutrition caused by the lack of mineral nutrients in underdeveloped countries [14]. Local landraces collected from Karnataka and Maharashtra provinces have not been studied adequately to develop lines that are suitable for various food and industrial purposes. The present investigation was accordingly planned to identify the extent of genetic variation in local landraces with respect to grain yield and mineral and protein content before their use in crossbreeding programs.

2. Material and methods

2.1. Plant material

The material used in this study comprised 92 sorghum landraces and 20 varieties, including the popular check variety M-35-1 adapted to the post-rainy season in the Indian states of Karnataka, Maharashtra, and Andhra Pradesh (Table S1). These genotypes were grown in two replications in a randomized complete block design (RCBD) at the Experimental and Gamma Field Facility, Bhabha Atomic Research Centre, Trombay, Mumbai (19° 03′ N, 72° 93′ E) during the post-rainy season in the 2013 crop season. The experiment was laid out on medium to deep black soils in two rows of 5 m length with 45 cm × 15 cm spacing. All agronomic practices were followed to raise a healthy crop. The effect of soil heterogeneity (nutrient and fertility levels) was addressed by means of the replicated trial. Seed index was recorded as the weight of 100 kernels from bulk seeds from each head of the genotypes grown. Selfed seeds were harvested from each genotype and replicated grain samples (20 g) were used for mineral and protein assays.

2.2. Micronutrient estimation

Mineral (micronutrient) content of the sorghum genotypes, including copper (Cu), zinc (Zn), iron (Fe), manganese (Mn), calcium (Ca) and magnesium (Mg), were estimated by atomic absorption spectrometry. A dried seed sample of each genotype was ground to fine powder and 1 g powder was digested on a hotplate using a 5:1 mixture of Nitric acid and Perchloric acid. The digested samples were subjected to mineral analysis with a GBC 932B+ atomic absorption spectrophotometer (GBC Scientific Equipment, Melbourne, Australia) with an air–acetylene flame. The estimated concentrations of minerals were expressed as mg per 100 g of the sample.

2.3. Determination of total protein content

The nitrogen content of the sorghum genotypes was determined by the Kjeldahl method using a KEL PLUS distillation unit (Pelican Equipment, Chennai, India) [15]. A sorghum flour sample (200 mg) was digested with concentrated H_2SO_4 in the presence of a catalyst and was heated in a chamber to 350 °C. The clear solution was cooled and distilled to trap ammonia. Dissolved ammonia was estimated by titration and the nitrogen level was estimated by formula (AOAC Official Method 950.48). The crude protein content of the sample was calculated as 6.25 times its nitrogen content and expressed as a percentage.

2.4. Data analysis

Data were recorded for five plants in each accession and replication. The data were subjected to analysis of variance for each environment and for the combined data using PROC GLM of SAS 9.1 [16]. Genetic parameters were estimated to identify variability among accessions and determine genetic and environmental effects on different traits. Genotypic (σ^2_G), phenotypic (σ^2_P), and error (σ^2_E) variances were calculated for

Download English Version:

https://daneshyari.com/en/article/2079540

Download Persian Version:

https://daneshyari.com/article/2079540

Daneshyari.com