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Genetic analysis of grain yield and agronomic traits of quality protein maize inbred lines and their single-cross hybrids under drought stress and well-watered conditions

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ABSTRACT

Drought-tolerant maize hybrids are crucial to enhance productivity in West and Central Africa. The objectives of this study were to (i) determine the combining abilities of tropical quality protein maize (QPM) inbred lines, (ii) identify hybrids with outstanding yield performance under drought stress (DS) and well-watered (WW) conditions, and (iii) identify drought-adaptive traits for index selection under DS. Seventy-eight hybrids developed from a diallel cross among 13 QPM inbred lines were evaluated under DS and WW conditions. The hybrids differed significantly ($p \leq 0.05$) for grain yield (GY) and other traits. General combining ability (GCA) and specific combining ability (SCA) were significant for GY and other traits. Four hybrids (CRIZEQ-24 × CRIZEQ-77, CRIZEQ-44 × CRIZEQ-77, CRIZEQ-14 × CRIZEQ-49, and CRIZEQ-24 × CRIZEQ-40) were identified with outstanding GY performance under DS. Days to anthesis, ear aspect, number of ears per plant and plant aspect were important traits for selection under DS.

1. Introduction

Maize (*Zea mays* L.) is an important food security crop in developing regions such as sub-Saharan Africa (SSA), Latin America and Southern Asia [1]. In SSA, maize is used in a variety of traditional foods, as green maize and as a major component in local weaning foods [2,3]. The majority of cultivated normal endosperm maize cultivars contain low levels of essential nutrients in their kernels [4]. Consequently, growth impairments and other diseases induced by nutrient deficiencies such as kwashiorkor, pellagra, night blindness and acute respiratory infections are common in SSA due to over reliance on maize-based diets [4–6] without dietary nutrient supplements. To remedy these challenges, considerable efforts must be made through conventional breeding to develop maize cultivars with enhanced nutritional quality attributes. Several varieties of quality protein maize (QPM), enhanced with two essential amino acids (lysine and tryptophan) [7, 8], Zn-enhanced maize [9], as well as orange maize which is rich in provitamin A [10] have been released and commercialized worldwide. A classic example is 'Obantanpa', a popular open-pollinated QPM that is widely grown in Western and Eastern Africa [11]. Quality protein maize varieties contain about 55% more of tryptophan and 30% more of lysine than normal maize [12]. However, despite the successes achieved in improving the nutritional attributes of the crop, yields on farmers' fields remain low under stress conditions such as drought.

The global climate change and erratic precipitation are major contributing factors to the occurrence of drought around the world [13, 14]. Drought is one of the most important abiotic stresses affecting maize production and productivity and can occur at any stage of its growth and development [15–17]. Severe drought can cause substantial yield losses by negatively affecting growth, physiology and reproduction of the crop [14,18]. Yield losses could be as high as 90%, especially when it occurs few days before anthesis to the end of the grain-filling period [19–21]. With the continuous changes in climatic conditions in SSA, it is likely that occurrence of drought events will become more frequent and severe [22] in the coming years. Unfortunately, growing maize under irrigation is a control measure outside the reach of the resource-constrained farmers [23]. Currently, most farmers in

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