Heterosis and combining abilities for multiple resistance to *Turcicum* leaf blight and maize streak virus

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Abstract

Fifty two single crosses were evaluated for resistance to Turcicum Leaf blight (TLB) and Maize Streak Virus (MSV) resistance across several locations in Uganda in 2009. The crosses were grown in 1-row plots with 2 replications. Subsequently 108 triple crosses from the 54 F1s were evaluated in 2-row plots for both diseases and agronomic performance in multi-environments during the second season of 2009. Genotypes were considered fixed and environment random. GCA and SCA effects were significantly different among parents and among crosses. Interactions of Environment with GCA and SCA were significant for both TLB and MSV. Plant height and yield were also significantly affected by Crosses x Environment interaction.

Key words: Crosses, environment, general combining ability, maize streak virus, specific combining ability, Turcicum leaf blight

Résumé


Mots clés: Croix, environnement, aptitude générale à la combinaison, virus de strie du maïs, aptitude spécifique à la combinaison, brûlure de la feuille de Turcicum
Maize occupies a strategic position in the food security of Uganda as in several countries in sub-Saharan Africa. In Uganda it is estimated that 2.5 million households are involved in the production of maize with annual cultivation coverage of 400,000 - 500,000 hectares (PSF, 2003). Although maize germplasm shows great variability, recurring biotic and abiotic constraints have devastating impacts on its productivity and quality (Fakorede et al., 2003; Pratt et al., 2003; Amusa et al., 2005; Asea et al., 2009). Significant yield loss in the lowland tropical and highland agroecologies of Uganda is attributed to Maize streak virus (MSV), *Turcicum* leaf blight (*Exserohilum turcicum*) (Kyetere et al., 1998; Taiwo et al., 2005; Lagat et al., 2008; Vivex et al., 2009). Use of resistant maize cultivars reduce yield losses to the two diseases and slow down the spread of TLB and MSV diseases (Adipala, E., 1994; Mawere et al., 2006).

Therefore, evaluation of maize lines with multiple resistance to foliar diseases, based on understanding of genetic mechanisms of leaf disease resistance, would be of benefit to seed companies and farmers in Uganda. Some of the maize inbred lines recently developed by National Crops Resources Research Institute (NaCRRRI) in Uganda are known to have resistance against grain weevil. However, their reactions to TLB and MSV have not been characterised. The objectives of this study were to characterize 12 selected Ugandan maize inbred lines for reactions to TLB and MSV, and evaluate the triple test crosses for agronomic performance and resistance to both diseases in multi environments.

In many economically important plant pathosystems, disease is controlled by breeding for genetic resistance in the host plant (Fakorede et al., 2003; Pratt et al., 2003). The genetics of northern leaf blight resistance have been extensively studied and are the subject of a recent review (Welz and Geiger, 2000). Efforts to control northern leaf blight (NLB) of maize (*Zea mays* L.), caused by the fungus *Exserohilum turcicum* (Pass.) Leonard & Suggs (syn. *Helminthosporium turcicum* Pass.; perfect state, *Setosphaeria turcica* (Luttrell) Leonard & Suggs, syn. *Trichometasphaeria turcica* Luttrell), have been directed toward resistance since previous works (Sigulas et al., 1988; Adipala, 1994; Slavica et al., 2007). The most feasible method of controlling MSV disease has been through use of resistance materials, since cultural practices such as use of chemicals and
rouging of diseased plants are economically and environmentally unsustainable (Lagat et al., 2008; Magenya et al., 2008).

Study Description

Experiments were carried out in Alpha lattice design at Namulonge, Masaka and Serere in Uganda during first and second rains of 2009. The three sites represent diverse agro-ecologies of Uganda - Namulonge in central Uganda represent the humid, forest-wet central region; Masaka is also wet, while Serere represented the savanna grassland (cereal-farming system) of eastern and northern Uganda. Fifty two (52) single crosses and two local checks, obtained from NaCRRI, were evaluated for TLB and MSV. The experiments consisted of 1-row plots each with 2 replications, planted at Namulonge and Masaka on 15th and 17th April 2009, respectively. A screen house trial involving the same 54 entries was also performed. Leafhoppers reared at NaCRRRI and maize leaves infected with TLB from field at NaCRRRI were used as sources of artificial inoculation. Subsequently 108 triple crosses developed from the 54 F₁s were evaluated in 2-row plot experiments for both diseases and agronomic performance during the second rains 2009 (September - December 2009). The same 108 materials were evaluated for resistance to TLB and MSV under screen house conditions following the procedures outlined above. Data were analysed for combining abilities (Griffing, 1956) and heterosis was estimated following the methods used by Lim and White (1978). Hybrid x Tester analysis was performed based on data combined across environments. Estimates of general (GCA) and specific (SCA) combining ability were based on approach given by Dabholker (1992). Hybrids and Testers were considered fixed and environment random.

Results

Diallel analysis across environments showed significant GCA and SCA effects among the genotypes for the traits under study. This indicates that the 12 inbred lines should have good combination performance. Mean squares for GCA were more than those of SCA for most traits indicating the availability of non-additive gene effects for controlling those traits. Resistance to TLB, MSV and yield parameters is controlled by GCA effects with presence of dominant genes (Ojulong et al., 1996; Welz et al., 2000; Okello et al., 2006; Lagat et al., 2008; Balint-Kurti et al., 2009; Vivek et al., 2009). Environment, Crosses, GCA and SCA, and their various interactions with Environment were significant suggesting that the hybrids did not have the same relative performances among environments (Table 1). Variations due to SCA x Environment were not
significantly different from zero for TLB and MSV. The results agree with those of Nass et al. (2000), Gama et al. (2005), Vivek et al. (2009) and Vieira et al. (2009). The higher GCA effects suggest that contribution to synthetic variety development could be effective and the significant SCA effects could be useful when high yielding specific combinations are desired; especially in hybrid maize development where selection of parental material is required (Paterniani et al., 2000; Malik et al., 2004; Silva and Moro, 2004).

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**References**


