Research Application Summary

Mechanisms of resistance in tropical maize inbred lines to spotted stem borer (*Chilo partellus*)

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Abstract

This study examined the mechanisms of stem borer resistance in CIMMYT tropical inbred maize. Kenya is a producer of maize, but cannot satisfy its domestic needs. The maize stalk borers are among the production constraints that are responsible for the low maize yields in Kenya. One hundred and twenty CIMMYT tropical inbred lines were planted at Kiboko Field Station in October 2011 and March 2012. Ten (10) plants from each entry were artificially infested with *Chilo partellus* neonates three weeks after planting; 17 plants were protected from borer damage using an insecticide. The experiment was designed as an alpha lattice and replicated 3 times. Data were collected from five of the infested plants through destructive sampling. Data were collected on several borer resistance attributes and also on grain yield. There were significant ($P<0.05$) differences among germplasm for the different resistance mechanisms, with genotypes expressing one or a combination of the different mechanisms. Canonical discriminant analysis indicated that trichome density was the most important trait conferring resistance. Genotype MBR C5 Bc F8-1-1-1-B-2-2-B -B-B was the most stem borer resistant line.

Key words: canonical discriminant analysis, *Chilo partellus*, maize, resistance mechanism

Résumé

Cette étude visait à identifier les mécanismes de résistance au foreur de tige dans la lignée de maïs tropical du CIMMYT. Le Kenya est un producteur de maïs, mais ne peut pas satisfaire ses besoins internes. Les foreurs de tiges de maïs sont parmi les contraintes de la production, qui sont responsables de faibles rendements du maïs au Kenya. Cent vingt lignées tropicales du CIMMYT ont été plantées à la station de culture de Kiboko en Octobre 2011 et Mars 2012. Dix (10) plantes de chaque entrée

étaient artificiellement infestées part de nouveau-nés de *Chilopartellus*, trois semaines après la plantation; 17 plantes ont été protégées contre les dommages causés par les foreurs en utilisant un insecticide. L'expérience a été conçue comme un réseau alpha et reproduite 3 fois. Les données ont été recueillies auprès de cinq des plantes infestées par échantillonnage destructif. Les données ont été recueillies sur plusieurs attributs de résistance aux foreurs ainsi que sur le rendement en grain. Il y a eu des différences significatives (P <0,05) entre les ressources génétiques pour les différents mécanismes de résistance, avec les génotypes exprimant un mécanisme ou une combinaison des différents mécanismes. L'analyse discriminante canonique a indiqué que la densité des trichomes était le trait le plus important conférant une résistance. Le génotype MBR C5 Bc F8-1-1-1-B-2-2-B-BB était la ligne la plus résistante au foreur des tiges.

Mots clés: Analyse discriminante canonique, *Chilo partellus*, maïs, mécanisme de résistance

Background

Maize is an important food crop in Kenya. Although the country produces maize, in most cases there is a deficit of the produce which must be met through imports. Kenya imports between 13-15% of its annual maize consumption needs to cater for the deficit. The maize deficit in Kenya is due to the decreasing production brought about by several biotic and abiotic stresses. On average, maize stem borers account for 13.5% grain losses; in general however, damage depends on the maize variety and the stage of attack. Host plant resistance as an approach to pest management is beneficial to the farmer as it confers many advantages. Resistant maize seeds provide an inherent control that eliminates the risks to environmental hazards, and is compatible to other insect pest control methods (Kfir *et al*., 2002a). Plant morphology and physiological attributes are essential for host plant resistance by influencing the susceptibility of a plant genotype to insect pests for feeding, oviposition, growth and development (Afzal *et al*., 2009). Developing resistance to maize stem borers could be enhanced by identifying genotypes with different mechanisms of resistance. This study was aimed at identifying the mechanisms of stem borer resistance in CIMMYT tropical inbred lines.

Literature Summary

Maize inbred lines are an important resource for breeding. The novel use of maize inbreds requires knowledge of genetics and an understanding of the partitioning of genetic diversity among

them (Liu *et al*., 2003). In maize, inbred plants are important in that hybrid maize is produced by cross-pollinating two unrelated male and female plants. Tropical inbred lines have been shown to have the greatest diversity for genetic structure capturing over 80% of the allelic diversity in landrace accessions. The judicious use of resistant inbred lines would help in the development of resistant maize varieties. Three types of resistance mechanisms to insect pests exists namely non-preference (antixenosis), antibiosis and tolerance (Painter, 1951). Trichome density, leaf and stem hardness are important forms of physical resistance mechanisms (antibiosis) against maize stem borer damage (Kfir *et al*., 2002b). On the other hand, higher levels of pith sugars contribute to increased borer susceptibility in maize (Grof *et al*., 2007). Knowledge of the different mechanisms of resistance present in tropical inbred lines will boost the search for new and higher levels of resistance in maize genotypes.

Study Description

The research study was conducted at Kenya Agricultural Research Institute (KARI), Kiboko field station during the October 2011 and March 2012 rainy seasons. One hundred and twenty CIMMYT tropical inbred lines were planted into 7 meter plot rows of 28 plants spaced at 0.75x0.25m. Ten (10) of the plants were artificially infested with *Chilo partellus* neonates three weeks after planting. The experiment was designed as an alpha lattice and replicated 3 times. Seventeen plants were protected from borer damage using an insecticide, and five of them were used for data collection through destructive sampling. Data were collected on leaf damage, number of stem exit holes, cumulative tunnel length (cm), trichome density, pith sugars content, leaf toughness, stem toughness and grain yield. A selection index was developed using the three damage parameters for categorising the lines into either resistant or susceptible.

Research Application

The germplasm showed significant differences in all mechanisms of resistance assessed ($P<0.05$). Variations between genotypes and the different mechanisms were however noted. Very few of the resistant inbred lines expressed similar resistance mechanisms, several exhibited one or a combination of different mechanisms, a suggestion that the genotypes used different mechanisms to resist borer damage. Canonical discriminant analysis indicated that trichome density was the most important trait conferring resistance followed by leaf toughness, pith sugar content and stem hardness in that

order. The selection index indicated that MBR C5 Bc F8-1-1-1-B-2-2-B -B-B, a CIMMYT multi-borer resistant line was the most resistant (0.47) while CML 441 (1.85) was the most susceptible.

Recommendation

This study confirmed that several resistance mechanisms exist in tropical inbred lines. Genotypes with high trichome densities exhibited the higher resistance. For effective development of hybrid maize with high levels of resistance, a combination of the different mechanisms in resistant inbred lines should be explored in future breeding programmes for maize stem borer resistance.

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