Research Application Summary

Genetic diversity for resistance to larger grain borer in maize hybrids and open pollinated varieties in Kenya

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Abstract

Modern maize varieties and hybrids possess improved agronomic performance and tolerance to abiotic and biotic stresses. However, breeding for the traits that contribute to resistance to post harvest pests have not been given due attention. In Africa, lack of resistant varieties and appropriate grain storage technologies lead up to 20-30% losses, particularly due to post harvest pests. The larger grain borer (LGB) is currently the most damaging post-harvest pests of maize, causing substantial losses, and aggravating hunger and poverty. A total of 100 genotypes comprising of hybrids and open pollinated varieties were evaluated in Kiboko from October 2009. A 20x5 alpha lattice design with three replications was used. Morphological and bio-physical traits were measured. Harvested maize genotypes were sun dried for a week after which samples of 100g were taken for evaluation for larger grain borer resistance. The samples were incubated under ambient conditions for three months after which the contents of each jar were sieved to separate grains, insects, and powder (flour produced). There were significant ($P<0.05$) differences among the maize genotypes on the amount of flour produced due to larger grain borer damage, the number of damaged and undamaged grains and the number of live and dead insects. The study is on-going and will be repeated.

Key words: Breeding, maize, post-harvest pests

Résumé

Les variétés modernes et les hybrides de maïs possèdent la performance agronomique et la tolérance améliorées aux stress abiotiques et biotiques. Cependant, la reproduction pour les traits qui contribuent à la résistance aux parasites après la moisson n'a pas été donnée avec une attention. En Afrique, le manque de variétés résistantes et les technologies appropriées de stockage de grain amènent à 20-30% de pertes, particulièrement dues aux parasites après la moisson. Le plus grand perceur de grain (LGB) est actuellement le parasite le plus préjudiciable du mais après la moisson, causant des pertes énormes et aggravant la faim et la pauvreté. Un total de 100 génotypes comportant des hybrides et des variétés pollinisatrices ouvertes ont été évalués dans Kiboko à partir d'octobre 2009. Une conception de treillis alpha 20x5 avec trois répliques a été employée. Des caractéristiques morphologiques et biophysiques ont été mesurées. Les génotypes moissonnés de maïs étaient séchés au soleil pendant une semaine après laquelle des échantillons de 100g ont été pris pour l'évaluation pour une plus grande résistance au perceur de grain. Les échantillons ont été incubés dans les conditions ambiantes pendant trois mois après lesquels le contenu de chaque fiole a été tamisé pour séparer des grains, des insectes et de la poudre (farine produite). Il y avait les différences significatives (P<0.05) parmi les génotypes de maïs sur la quantité de farine en raison de plus grands dommages de perceur de grain, le nombre de grains endommagés et intacts ainsi que le nombre d'insectes en vie et ceux tués. L'étude est en cours et sera répétée.

Mots clés: Reproduction, maïs, parasites après la moisson

Background

The larger grain borer (*Prostephanus truncatus* Horn) is a storage pest which is among the major pests responsible for serious losses of maize worldwide. Its damage results directly in lost food, and may also reduce future maize production for farmers who use saved grain as seed in the tropics (Pingali and Pandey, 2001).

Host plant resistance through genetic improvement remains a major component of an integrated pest management strategy to minimize storage losses and impact on grain quality. To design effective breeding methods, breeders need new and better sources of resistance and increased knowledge of their genetics. Therefore the objective of this study was to determine genetic diversity among maize hybrids and open pollinated varieties (OPVS) for resistance to the larger grain borer based on phenotypic and molecular data sets.

Literature Summary

Maize is a staple food for most households in Sub-Saharan Africa. Its production for food by smallholder farmers often plays a vital role in alleviating poverty through income generation and contributes positively to local and national economies. The larger grain borer (*P. truncatus*) is an important pest for stored maize in the tropics. Thus, breeding for resistance to it is crucial, especially as this influences the adoption of improved varieties.

There are three resistance components of plants to insect pests namely, antibiosis, non-preference and tolerance which have been studied and found to be important for grain resistance to storage pests (Derera *et al*., 2001). Non-preference is the heritable feature of the grain, which discourages insects from feeding, colonising and oviposition or a combination of the three. Grain texture has been suggested as the basis of non-preference resistance because the smooth pericarp may deter storage pests from feeding and oviposition. Antibiosis denotes plant characters that result in adverse effects on the insect's life history when the insect uses a resistant plant for food, while tolerance denotes a resistance whereby the plant shows an ability to grow and reproduce itself or to repair injury to a marked degree inspite of supporting a population approximately equal to that damaging a susceptible host. Evaluation of resistance to stored-grain pests should focus on measuring antibiosis and or non-preference because tolerance does not function in stored grain (Derera *et al*., 2001).

Genetic diversity for storage pest resistance is an entry point for progress in understanding the biochemical, biophysical and genetic basis of host plant resistance. Various biochemical and physical characteristics have been identified as mechanisms of kernel resistance to storage pests. Studies that have used germplasm with more diversity have confirmed the heritability of maize weevil resistance and it would be possible to introduce the trait into elite germplasm (Derera *et al*., 2001). It is thought that this might be the case for the larger grain borer.

Study Description

A total of one hundred genotypes comprising of hybrids and open pollinated varieties were evaluated in Kiboko in Kenya from October 2009 to February 2010. The design was an alpha lattice replicated thrice. Each plot consisted of two rows of five meter length with inter-row spacing of 0.75 m and 0.25 m within rows. Appropriate fertilizer and watering was applied to ensure establishment and healthy growth of the plants. Morphological traits measured in the field included plant height, ear height, husk cover and grain moisture. Biophysical characters to be evaluated included ear texture (flint=1 to dent=9). The parameters determined in the insect bioassay included percentage grain weight loss, damaged kernels, number of adult progeny and flour production.

Harvested maize genotypes were sun dried for a week after which samples for evaluation for larger grain borer resistance were taken and disinfested by fumigation in plastic drums using Phostoxin™ (phosphine gas) for 7 days. The one hundred gram samples of each maize genotype were placed into 500 ml jars with a perforated lid and replicated thrice. Fifty three week old unsexed adult larger grain borer were then introduced into each jar. The samples were incubated under ambient conditions for three months after which the contents of each jar were sieved to separate grains, insects, and powder. Experimental design in the laboratory was a randomized complete block design with 3 replications of 100 g for each of genotype, with each replication being represented by a shelf on which the samples were placed. The dust was weighed and expressed as a percentage of the original weight. Adult insects were counted (live and dead) and the grains sorted into damaged (grains with holes and/or tunnels) and undamaged grains. Grains in each fraction were counted and weighed and expressed as a percentage. Resistant and susceptible checks were included in the screening.

The values of sampled observation for different phenotypic traits were subjected to analysis of variance, a tool which allows comparison of multiple processes/populations with regard to possible differences in the effect of one or more factors. This was done using the statistical analysis software (SAS).

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There were significant (P<0.05 differences among the maize genotypes with respect to the amount of flour produced due to larger grain borer damage, the number of damaged and undamaged grains and the number of live and dead insects. The samples which had high weight of the flour produced had the highest number of live insects (Table 1). Some of the entries such as 68 and 77 had reduced flour production but high live insects were in large numbers. This may have been due to the fact that conducive conditions prevailed for the insects to multiply fast without necessarily damaging the grains completely.

From the results it appeared that genetic diversity to the larger grain borer existed among the maize hybrids and this offers opportunity for developing resistant varieties to the storage pest.

Recommendation

It is recommended that the genetic diversity for resistance to larger grain borer be studied further using molecular markers.

Table 1. Flour weight and number of live and dead larger grain borer insects after two months of incubation in one selected genotypes.

Entry	Flour weight	Alive insects	Dead insects	Entry	Flour weight	Alive insects	Dead insects
3	28.6	147	79	86	15	65	48
4	28.7	162	80	77	14	140	29
12	30.4	227	87	67	14	92	33
24	31.12	204	64	68	14	122	37
2	31.9	184	85	94	14	83	41
1	32.7	152	63	100	13.7	102	37
5	34.3	200	56	75	11	80	38

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