

Research Application Summary

Early-generation testing for developing maize inbreds with drought tolerance and resistance to Turcicum Leaf Blight and streak virus in Uganda

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Abstract

In maize breeding, test crosses can be done in early stages of selfing or delayed until inbreds are close to homozygosity at F_5 or F_6 . Although early generation testing may be efficient there is need to obtain information on genetic components of variance and on inbred-hybrid correlations for performance and disease traits, in order to develop an effective selection strategy for inbreds that will produce high yielding, drought tolerant, and disease resistant hybrids. Therefore, a study was carried out at National Crops Resources Research Institute (NaCRRI), to determine the relative magnitude of genetic and genotype x environment variances among early generation testcrosses, for maize streak virus (MSV) and turcicum leaf blight (TLB), anthesis-silking interval (ASI), yield and inbred testcross correlation. Analyses of 89 F_3 families showed a significant positive relationship between F_2 and F_3 s for silking date, ASI, TLB and plant aspect (PA). Correlation regression and narrow sense heritability of these traits were positive and significant for SD, TLB and PA. Narrow Sense Heritability (NSH) was 44% for ASI, 35 for SD and 25% for TLB.

Key words: Diseases, maize breeding, narrow sense heritability

Résumé

Dans la reproduction du maïs, des crois de test peuvent être faites dans les premiers stades de l'autofécondation ou retardées jusqu'à ce que lignées soient proches de l'homozygotie chez F_5 ou F_6 . Bien que les tests de première génération peut être efficace, il est nécessaire d'obtenir des informations sur les composants génétiques de la variance et des corrélations lignée-hybrides pour les traits de performance et de la maladie, afin de développer une stratégie de sélection efficace pour les lignées qui produiront un rendement élevé, résistantes à la sécheresse, et des hybrides résistants aux maladies. Par conséquent, une étude a été réalisée à l'Institut National de Recherche en Ressources Culturelles (NaCRRI), afin de déterminer l'importance relative des écarts d'environnement x des

ressources génétiques et du génotype entre les techniques de croisement de première génération, pour le virus de la striure du maïs (MSV) et la rouille des feuilles de turcicum (TLB), l'intervalle d'anthèse de la soie (ASI), le rendement et la corrélation de croisement des hybrides. Les analyses de 89 familles de F_3 ont montré une relation positive significative entre F_2 et F_3 pour l'échéance d'apparition des soies, ASI, TLB et l'aspect des plantes (PA). La régression de corrélation et l'héritabilité au sens étroit de ces traits étaient positives et significatives pour les SD, TLB et PA. L'héritabilité au sens étroit (NSH) a été de 44% pour l'ASI, 35% pour SD et 25% pour TLB.

Mots clés: Maladies, reproduction du maïs, héritabilité au sens étroit

Background

Maize is the number one cereal in the world, with a global production higher than that of rice and wheat. It is a main staple food for people in Africa but is also used worldwide as a fodder crop for livestock. Maize production is affected by several factors such as drought, flooding, weeds, pests and diseases. Therefore, it is necessary to improve the crops resistance to these stresses through breeding. By evaluating testcrosses during the early generations of selfing, lines that do not perform well are discarded to allow use of resources for the more promising lines. Early testing is based on the assumption that the combining ability of a line is manifested during the early stages of selfing, and does not change substantially with continued inbreeding (Hallauer, 1990).

Literature Summary

The discovery of the heterosis phenomenon, hybrid breeding technology and successful commercial exploitation of heterosis in maize are considered to be significant achievements and landmarks in the history of biological sciences during the present century (Hallauer, 1990). The maize hybrid development programme involves development and evaluation of inbred lines, crossing of selected inbreds and production of hybrids. By the nature of maize, crosses produce thousands of progeny lines which become difficult to evaluate. The Line x tester analysis, is one of the simplest and efficient methods of evaluating large number of inbreds / parents for their combining ability and other traits (Kempthorne, 1957).

Study Description

This study was carried out at three experimental sites: National Crops Resource Research Institute-Namulonge (NaCRRI) in

Central Uganda, Bulindi-Hoima in western Uganda and Serere in eastern Uganda. Some of the parental lines in this study were developed by the Uganda National Agricultural Research Organization (NARO) and others by the International Centre for Maize and Wheat Improvement (CIMMYT). The germplasm varied in resistance to turicum leaf blight (TLB), maize streak virus (MSV) disease and drought tolerance. The F_2 seed were advanced to F_3 , in the first rainy season of 2011 (2011A). Disease response and anthesis-silking interval (ASI) data were collected. The F_3 seed were planted and screened against MSV and TLB, and also evaluated for ASI. Reaction to MSV was done in the screen-house while TLB resistance evaluation, selfing and testcrossing were done in the field at Namulonge and Kasese. Testcross was done in Kasese to provide appropriate isolation distance. The Single Cross (SC) tester was used as a male (planted in multiple rows, bulked pollen) and F_3 lines as females (planted ear-per row) in single-row-plots in season 2011B, generating testcross (TC) populations.

The TC populations are currently (2012A) undergoing field evaluation in multi-location tests. Data to be collected on these crosses include days to flowering, plant height, cob length, 100-grain weight and grain yield per plant.

Research Application

Of the F_3 families generated, 89 families were selected and advanced to F_4 generation. The mean value recorded for ASI was -3 to 3 days in F_2 , and -3 to 6 days in F_3 . For this parameter, 67.4% of F_2 s ranged from -3 to 0 days while 29.2% of the F_3 families ranged from -3 to 0 days (Fig. 1).

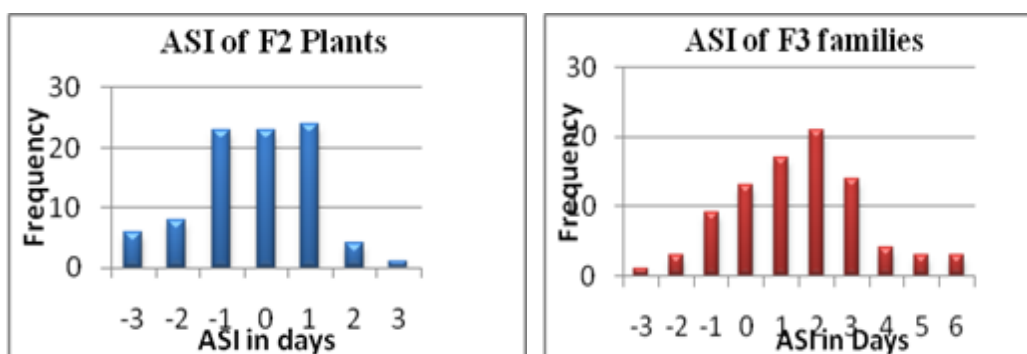


Figure 1. Anthesis Silking Interval (ASI) for F_2 and F_3 maize populations.

For TLB disease, 90.4% of F₂ progenies and 80.9% of F₃ progenies were resistant (scored 1-2.5). The distribution of plants within the various TLB resistance categories 1, 2, 3, 4 and 5 were 73, 21, 2, 1 and 2%, respectively in F₂ progenies and 15, 67, 13, 2 and 2%, respectively for F₃ progenies (Fig. 2).

Silking date (SD), turcican leaf bligth (TLB) reaction and plant aspect (PA) were significant positively correlated among F₂ and F₃ generations. Anthesis date (AD) exhibited a positive but non-significant relationship correlation coefficient (r = 0.04) between F_{2,3} generations (Table 1).

Narrow sense heritability (NSH), estimated from regression coefficient values are show in in Table 2. NSH was positive and highly significant for ASI (P<0.01, df=87), SD, TLB and plant aspect (P<0.05, df=87). However for anthesis date the value was not significant.

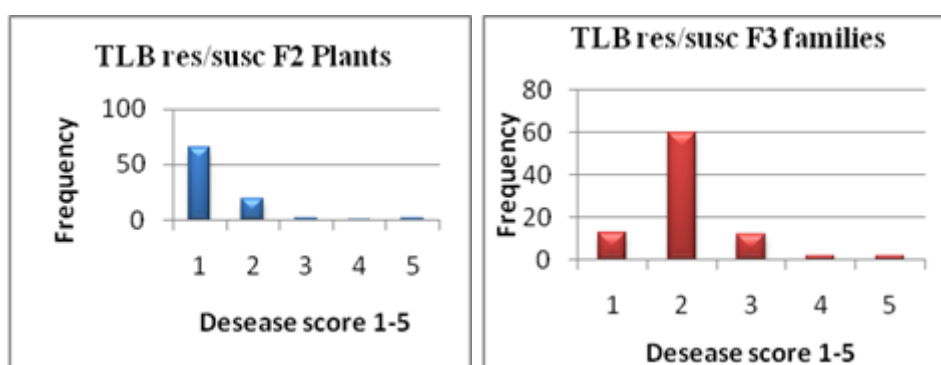


Figure 2. Distribution of F₂ and F₃ maize progenies within TLB resistance scores.

Table 1. Analysis of varienc table (ANOVA) for F₂ and F₃ maize generations for selected traits.

Source	Df	Anthesis date	Silking date	AS-interval	TLB resist	Plant aspect
Regression	1	45 ^{ns}	81*	30.3**	1.3*	2.21*
Residual	87	13	17	3.3	0.29	0.46

**Significant at α of 0.05 and 0.01 respectively.

Table 2. Narrow sense heritability values for for selected traits.

	A. Date	S. Date	AS-Interval	TLB	P.A
Regression coefficient (b)	0.30	0.35*	0.44**	0.25*	0.16*

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