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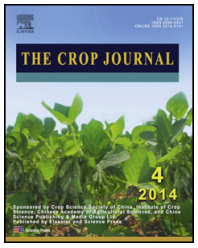

Evaluation of maize inbred lines currently used in Chinese breeding programs for resistance to six foliar diseases

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ABSTRACT

Foliar diseases are common in most maize-producing regions and have caused serious yield reduction in China. To evaluate genetic resistance of parental lines actively used in maize breeding programs to major foliar diseases, 152 maize inbred lines were tested against northern corn leaf blight (NCLB), southern corn leaf blight (SCLB), *Curvularia* leaf spot (CLS), gray leaf spot (GLS), common rust, and southern rust from 2003 to 2005. A small number of lines exhibited highly resistant reactions to common rust and southern rust, but none were highly resistant to NCLB, SCLB, CLS, and GLS. Although 53.3%, 40.8%, and 80.7% of lines were resistant to NCLB, SCLB, and common rust, the resistance in most lines was moderate. Resistance to CLS, GLS, and southern rust was rare in this collection of maize lines. Five lines, 313, Chang 7-2, Qi 319, Qi 318, and Shen 137, were resistant to five diseases tested. Lines belonging to heterotic subgroup PB exhibited better resistance to the foliar diseases than lines from other heterotic subgroups, such as BSSS, PA, Lancaster, LRC, and PA. The results will be of benefit to breeders for selecting lines in disease resistance breeding programs.

1. Introduction

Maize (*Zea mays* L.) is the largest crop in China, and is grown throughout the country from the spring maize belt in northeastern region to the southwestern mountain spring maize belt. In 2012, maize was planted on 3.50 million hectares and the total production of corn was 206 million tons, accounting for 31.9% and 35.7% of the total areas and production of the cereal crops, respectively (http://data.stats.gov.cn/workspace/index;jsessionid). The average yield of maize was 5.7 tha^{-1}. Since

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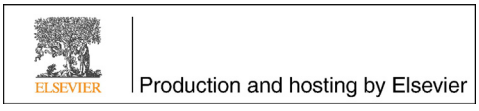

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2000, the growing area, total production and the average yield of maize have increased by 51.9%, 94.0%, and 27.7%, respectively. However, the occurrence of various foliar diseases has become a serious yield limiting factor in most maize producing regions throughout the country.

Northern corn leaf blight (NCLB), caused by *Setosphaeria turcica* (Luttrell) Leonard et Suggs, anamorph: *Exserohilum turcicum* (Pass.) Leonard et Suggs is one of the most harmful diseases in the spring corn regions. In the late 1980s, use of the inbred line Mo 17 originating from the USA, which carries gene *Ht* for resistance to NCLB, effectively controlled this disease. Recently, the outbreak of NCLB has resulted in severe yield losses in northeastern and northern China. Owing to cultivation of resistant hybrids, the shift of *E. turcicum* race 0 in the 1980s to race 1 in the 1990s and the occurrence of other races have resulted in severe economic losses [1–3]. Southern corn leaf blight (SCLB) *Cochliobolus heterostrophus* (Drechs.) Drechs., anamorph: *Bipolaris maydis* (Nisikado et Miyake) Shoemaker is a major yield limiting disease in the summer corn regions. The predominant race of *B. maydis* is race O, which accounts for 79.7% of isolates. The frequencies of races C, T, and S were 5.0%, 10.0%, and 5.3%, respectively [4]. Although recently released commercial hybrids are effective against this disease, it is desirable to identify more resistant inbred lines from different resources with diverse resistance genes, because more virulent *B. maydis* races have been found in commercial fields [4]. During the late 1980s, epidemics of *Curvularia* leaf spot (CLS) (*Curvularia lunata* [Wakker] Boed.) were a serious problem in maize fields in the northeastern and northern regions [5]. In recent years, this disease has occurred in maize fields all over the country and has been severe in regions such as western Liaoning province and central Jilin province when weather conditions favored disease development [6,7]. Gray leaf spot (GLS) (*Cercospora zeae-maydis* Tehon et Daniels) occurs in spring maize growing areas, but is a major problem for maize production in Yunnan province and is widely epidemic in northeastern China including Heilongjiang province, the largest maize production area in China [8–14]. Common rust (*Puccinia sorghi* Schwein.) is frequently observed in the spring maize growing areas. The incidence of this disease is severe in certain areas, but has not resulted in serious economic loss except in Guizhou and Yunnan provinces. Prior to the 1980s, southern rust (*Puccinia polysora* Undrew) was one of the most important maize diseases in southeastern China, but the occurrence of this disease has been limited due to reduction of planting area in this region. Since 2000, southern rust has become a serious problem in the summer maize growing regions and more than 10% of yield losses have been recorded in some hybrid lines. In 2007 and 2008, the disease was observed in the northern part of the summer maize growing region including Beijing, central Hebei province, and southern Liaoning province, suggesting that southern rust will become epidemic throughout the summer maize growing region as well as some spring maize regions.

Foliar diseases occur mainly after the tasseling stage of maize, making them difficult to control with fungicides in the field. Thus, improvement of genetic resistance to the foliar diseases remains an important objective in maize breeding programs. Understanding of disease reactions is essential for parental selection and resistant hybrid development, as well as for mapping resistance genes [15–18].

In the past decades, growing resistant cultivars in most maize producing regions has effectively controlled some foliar diseases. However, severe yield losses have been incurred by new races of pathogens and changes of weather and planting density. For this reason there is a need to evaluate disease resistance in parental inbred lines from various maize growing regions and to identify resistant parents for maize improvement. In 2003, a project was initiated to assess reactions to 11 major diseases of maize inbred lines that are used in current breeding programs. The objective of the present study was to evaluate the reactions to NCLB, SCLB, CLS, GLS, common rust, and southern rust of a collection of parental inbred lines that are actively used in most maize breeding programs or are widely grown cultivars.

2. Materials and methods

2.1. Plant materials

One hundred and fifty-two inbred lines of maize were collected from the major maize breeding programs in China and the seeds were increased at the Maize Centre, Chinese Academy of Agricultural Sciences (CAAS), Beijing, China. Based on information of their pedigrees and genetic structures [19–21], 129 inbred lines were categorized into heterotic group A or B. Group A contained subgroups PA (group A germplasm derived from modern U.S. hybrids) (30 lines), BSSS (Iowa Stiff Stalk Synthetic population) (25 lines), and LRC (derivatives of Lvda red cob Chinese landrace) (19 lines); and group B consisted of subgroups PB (group B germplasm derived from modern U.S. hybrids) (18 lines), Lan (Lancaster Surecrop) (17 lines), and SPT (derivatives of Tangshan Sipingtou Chinese landrace) (20 lines). Twenty-three lines were not assigned to any subgroup, owing to a lack of pedigree or molecular genetic information (Table 1).

2.2. Evaluation of disease reactions

For accurate evaluation of disease reactions under appropriate environments, the screening nursery was located in disease epidemic areas: the NCLB nursery was in Harbin, Heilongjiang

Table 1 – Analysis of variance of 152 maize inbred lines.

Disease	Source	*df*	*SS*	*MS*	*F*	*Pr > F*
NCLB[a]	Line	151	865.6315	5.7327	5.73	<0.0001
	Year	1	0.8421	0.8421	0.84	0.3605
SCLB	Line	151	678.9473	4.4963	10.62	<0.0001
	Year	1	0.0526	0.0526	0.12	0.7249
CLS	Line	151	988.6316	6.5472	4.80	<0.0001
	Year	1	1.8947	1.8947	1.39	0.2406
GLS	Line	151	465.3553	3.0818	4.12	<0.0001
	Year	1	1.0658	1.0658	1.43	0.2344
CR	Line	149	715.4800	4.8019	6.28	<0.0001
	Year	1	0.0133	0.0133	0.02	0.8951
SR	Line	151	1050.7368	6.9585	3.24	<0.0001
	Year	1	0.0526	0.0526	0.02	0.8757

[a] NCLB: northern corn leaf blight; SCLB: southern corn leaf blight; CLS: *Curvularia* leaf spot; GLS: gray leaf spot; CR: common rust; SR: southern rust.