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Durable resistance to two leaf blights in two maize inbred lines

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Summary. It has been determined that the occurrence of 'durable resistance' as defined by Johnson and Kranz operates in maize inbred lines CM104 and CM105 against the leaf blight pathogens *Setosphaeria turcica* (= *Exserohilum turcicum*) and *Drechslera maydis* (= *Cochliobolus heterostrophus*), by analyzing data for 16 and 14 years, respectively. Essentially the methodology estimated the longevity of cultivar resistance by determining whether the regression coefficient of linear regression with years of testing and mean disease intensity is zero or not significantly different from zero. The values for both Turcicum Leaf Blight and Maydis Leaf Blight were not significantly different from zero. The resistant inbred lines have been used in hybrid combinations and have the potential to transmit this resistance to progenies in hybrid combinations that are governed by additive gene action.

Key words: Resistance – Leaf Blight – Maize

Introduction

In India, systematic research work on diseases of maize was initiated in the early 1960s. One of the purposes was identification of host resistance to major prevalent diseases with a view towards minimizing the loss in grain yield caused by them. A wide range of materials of indigenous and exotic origin was evaluated for the important diseases under conditions of artificial inoculation in the field and also at 'hot spot' locations. Among the 16 diseases out of 61 identified as major, four foliar diseases – Maydis Leaf Blight (*Drechslera maydis* Nishikado), Turcicum Leaf Blight [*Exserohilum turcicum* (Pass.) Leon. and Suggs], Common Rust (*Puccinia sorghi* Schw.), and Brown Stripe downy mildew (*Sclerophthora rayssiae* var. *zeae* Payak and Renfro) – occur every year in moderate to severe intensities (Payak and Sharma 1979, 1985).

Here, we present data generated with regard to the former two diseases (Maydis and Turcicum Leaf Blights) from two types of experiments: (a) evaluation under natural conditions in 'hot spot' locations, and (b) evaluation under artificial field inoculations.

Materials and methods

Two inbred lines C(oordinated) M(aize) 104 and CM105 were being maintained in the program as they are the parental lines of the released, double cross hybrids – Ganga 101 and Deccan. They have also been used by us in the formation of two multiple disease-resistant populations (Sharma et al. 1976). CM104 is an early generation, inbred line extracted from the Colombian variety 'Amarillo Theobromina'. It has yellow flint kernels, purple leaves and tassels, and good general combining ability for yield and flowers in 50–60 days in North India. CM105 was developed from a Peruvian cultivar Peru 330. The double cross hybrids (Ganga 101 and Deccan) have shown excellent resistance to foliar diseases in general under cultivation.

Disease evaluations were made in the field 10–15 days after silking. The data are based on multilocation tests covering almost all the agroclimatic zones of India in which maize is grown. These include Bajaura (32.3 °N, 77.0 °E, 1090 m, a.s.l.) in the north, Dharwad (15.25 °N, 76.70 °E, 678 m, a.s.l.) in the south, Godhra (22.45 °N, 74.40 °E, 119.4 m, a.s.l.) in the west, and Jorhat (26.46 °N, 94.16 °E, 91.0 m, a.s.l.) in the east. Thus, the material has been exposed to a wide spectrum of the pathogen population prevalent in India.

Experience has shown that the highest level of virulence of Maydis Leaf Blight is exhibited by the pathotype present in Udaipur/Banswara in Rajasthan, followed by those present at Kalimpong (West Bengal) and Dholi (Bihar). Artificial inoculations have been carried out at Delhi with the Rajasthan isolate.

Although race T of this pathogen has been recorded (Sharma et al. 1978) in India, it was not considered advisable to use it in this test as there is no breeding program involving male-

sterile cytoplasm. Its prevalence is restricted to the state of Punjab in the North. Even then, controlled tests were carried out in the greenhouse on CM105 and its male-sterile version (source, Texas Male Sterile). The line with normal cytoplasm showed only discrete, small lesions indicating resistance, and no blighting, as opposed to severe blighting in the male-sterile version (Ram Nath et al. 1973).

All disease evaluations included susceptible checks for comparison of disease reaction in the test entries. The reactions were assessed on the basis of a 9-point scale, which is a modification of that suggested by Elliot and Jenkins (1946). In the modified scale, 1 indicates very little or no infection and 5 indicates presence of large, coalescent lesions causing extensive blighting (Payak and Sharma 1983). Ratings of up to 2.0 are graded as resistant, while those above 2.5 have been categorized as susceptible.

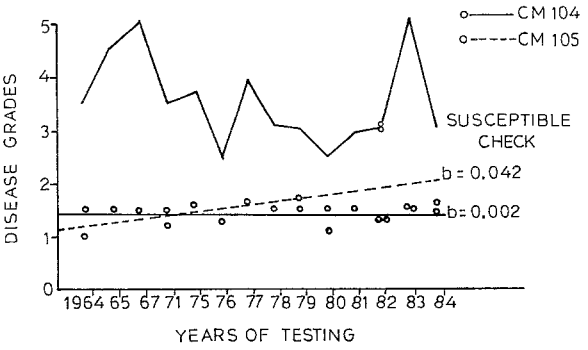

Fig. 1. Grades of maydis leaf blight in two inbred lines of maize for a period of 14 years at 19 locations

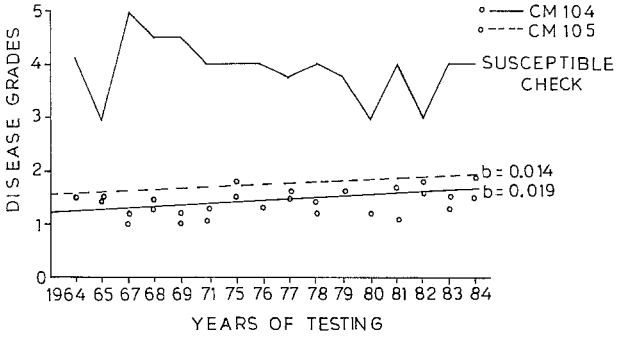

Fig. 2. Grades of turcicum leaf blight in two inbred lines of maize for a period of 16 years at 19 locations

Results and discussion

Durable resistance to a disease has been defined as 'the resistance that remains effective during its prolonged and widespread use in an environment favorable to disease' (Johnson 1983). The data generated over 14 years and at as many as 19 locations were analyzed according to the procedure outlined by Kranz (1983) for the estimation of longevity of cultivar resistance as indicator for durable resistance.

If the regression coefficient of linear regression (b) with X = years of testing and Y = mean disease intensity is zero or not significantly different from zero, then the cultivar can be stated to possess durable resistance. The regression of coefficient was computed according to the equation given by Kranz (1983).

Figure 1 depicts three curves where the Y-axis denotes Maydis Leaf Blight grades and the X-axis denotes calendar years from 1964 to 1984 (except 1966, 1968, 1969, 1970, 1972, 1973, and 1974). The lower curves show the level of disease in the inbred lines CM104 (solid line) and CM105 (broken line). The b value for CM104 is 0.002 and is not significantly different from zero. The same applies to the inbred line CM105. The highest disease rating in the susceptible check was 5.0 out of 5.0 in 1983. The mean disease rating never exceeded 1.6 in any year in CM105 or 2.0 in CM104 across locations and over years.

Figure 2, presented in an identical manner to that of Fig. 1, depicts grades of Turcicum Leaf Blight (Y-axis) over a period of 14 years (X-axis) for CM104 (solid line) and CM105 (broken line), along with disease scores in the susceptible check varieties. Here also the b value for CM104 (0.014) and CM105 did not deviate significantly from zero. The mean disease rating in the two inbred lines never exceeded 1.6, while in the susceptible check it was as high as 5.0 out of 5.0 in 1967.

Inheritance studies have been carried out by Jha and Dhawan (1970) on Turcicum Leaf Blight using a 8×8 diallel under two different environments in which CM105 was included. This line was not only found to be a good general combiner for imparting resistance in hybrid combinations, but possessed the highest number of genes dominant for resistance. The mean disease rating and general combining ability effects also showed good agreement, indicating that the line is prepotent in transmitting resistance.

Handoo (1969) carried out genetic analysis of resistance to Maydis Leaf Blight using a 8×8 diallel. The two inbred lines CM104 and CM105 were included as resistant parents. In this case, it was shown that both lines were good general combiners for imparting resistance, and they also possessed the maximum number of genes dominant for resistance.

According to Sharp (1983), 'apparent' durable resistance could be either monogenic or polygenic. An example of the former type is that found in the leaf spot disease of maize caused by *Helminthosporium carbonum* (Ullstrup and Brunson 1947). Polygenic resistance has been observed in Turcicum Leaf Blight (*Exserohilum turcicum*) and Maize Rust (*Puccinia sorghi*) (Sharp 1983). Genes for polygenic resistance to the former disease could be concentrated or accumulated by recurrent selection. While the data suggest occurrence of durable resistance, critical tests for durability or longevity do not seem to

have been applied; the data must be subjected to the test formulated by Kranz (1983) to obtain a certain measure of reliability. In our study, the data conform to this test.

References

Elliot C, Jenkins MT (1946) *Helminthosporium turcicum* leaf blight of corn. Phytopathology 36:660–666

Handoo MI (1969) Genetic analysis of resistance to *Helminthosporium maydis* Nishikado and Miyake in maize (*Zea mays* L.), PhD thesis, Indian Agricultural Research Institute, New Delhi

Jha TD, Dhawan NL (1970) Genetic analysis of resistance to *Helminthosporium turcicum* in inbred lines of maize. In: Raychaudhuri SP et al. (eds) Plant disease problems. Indian Phytopathological Society, New Delhi, pp 388–396

Johnson R (1983) Genetic background of durable resistance. In: Lamberti F, Waller JM, Van der Graaff NA (eds) Durable resistance in crops. Plenum Press, New York, pp 5–24

Kranz J (1983) Epidemiological parameters of plant resistance. In: Lamberti F, Waller JM, Van der Graaff NA (eds) Durable resistance in crops. Plenum Press, New York, 141–162

Payak MM, Sharma RC (1979) Resistance to diseases in maize – the Indian experience. Crop Improv 6:75–85

Payak MM, Sharma RC (1983) Disease rating scales in maize in India. In: Techniques of scoring for resistance to important diseases of maize. All India Coordinated Maize Improvement Project, Indian Agricultural Research Institute, New Delhi, pp 1–4

Payak MM, Sharma RC (1985) Maize diseases and approaches to their management in India. Tropical Pest Manage 31:302–310

Ram Nath, Lambat AK, Payak MM, Lilaramani J, Rani I (1973) Interception of race 'T' of *Helminthosporium maydis* on sorghum seeds. Curr Sci 42:872–874

Sharma RC, Payak MM, Mukherjee BK, Lilaramani J (1976) Multiple disease resistance in maize. Kasetsart J 10:135–136

Sharma RC, Payak MM, Kandhari J (1978) Outbreak of a new pathotype of *Helminthosporium maydis* on maize in India. Indian Phytopathol 31:112–113

Sharp EL (1983) Experience of using durable resistance in the USA. In: Lamberti F, Waller JM, Van der Graaff NA (eds) Durable resistance in crops. Plenum Press, New York, pp 385–396

Ullstrup AJ, Brunson AM (1947) Linkage relationship of a gene in corn determining susceptibility to *Helminthosporium* leaf spot. J Am Soc Agron 39:606–609