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SCREENING OF MAIZE GENOTYPES AGAINST SOUTHERN CORN LEAF BLIGHT

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ABSTRACT
A study was carried out, involving 119 maize genotypes to identify, the new sources of resistance to *'Maydis Leaf Blight'* under artificial epiphytotic condition at three locations viz, Almora, Nagenahalli and Varanasi for 12 years (1999-2011) with the help of three experiments. All the three experiments included separate sets of genotypes except 13 inbreds (CM-145, CM-141, CM-212, CM-126, V-341, V-336, V-348, V-342, V-273, V-346, V-335, V-338 and V-25) which were common in II nd and IIIrd Experiments. The present study has helped in the identification of 41 resistant, 41 moderately resistant, 24 susceptible and 13 highly susceptible maize genotypes. Ten lines viz. V53, V 178, V 190, V 336, V 340, V 341, V 345, V 348, CM 104 and CM 145 showed high level of resistance, whereas inbred lines *viz*., V 49, CM 126, CM 127, CM 202 and CM 212 showed high level of susceptibility as they scored above 3.5 disease score across the environment. The maize inbred lines CM 145, V 341, V 336 and V 348 expressed its high level of resistance in all the three environments. It was also observed that average disease incidence was high in Nagenahalli than Almora and Varanasi thus indicating that isolates of *Cochliobolus heterostrophus* were more virulent at Nagenahalli than rest of two environments.

INTRODUCTION

In India Maize is prone to a number of biotic stresses like foliar diseases, ear rot and stalk rot caused by fungi and bacteria, under favorable environmental conditions. These pathogens are capable of causing severe losses and deteriorate the quality of the produce. For minimizing the losses due to disease, it is necessary to introgress an adequate level of resistance against maize diseases of economic importance. Southern Corn Leaf Blight is one of the most important maize diseases and caused by the fungus *Bipolaris maydis*. This disease has great significance in the history of agriculture, because of its epidemic propositions in 1970 in US and subsequent devastation of most of the corn crop that year. It tends to be limited by temperature and climate to the warmer part of the US (Hooker *et al.,* 1970). Infected tissue is extensively covered with spots and chlorosis rendering them non productive. It is found to have a higher saprophytic ability (Blanco and Nelson, 1972) and hence high primary inoculums level will be likely to be found in areas with high disease occurrence. In South East Asia it is reported to cause heavy losses in Pakistan, India, Nepal, Kampuchea, Philippines, Indonesia, Vietnam and China. *'Maydis Leaf Blight'* is serious disease in India particularly in J & K, Himachal Pradesh, Sikkim, Meghalaya, Punjab, Haryana, Rajasthan, Delhi, UP, Uttrakhand, Bihar, MP, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. Almora, Nagenahalli and Varanasi are the centres for this disease screening in India. Ideal maize breeding programme with high level of SCLB resistance requires to be supported by additional new sources of resistance at regular intervals. New and stable additional sources of resistance are obtained by continuous screening of maize germplasm across the year and environment. Keeping this in view, the present investigation aimed at to identify new sources of resistance at SCLB for future maize breeding program.

MATERIALS AND METHODS

The present study was carried out at Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi; Zonal Agriculture Research Station, V.C. Farm, Mandya (Nagenahalli), Karnataka and VPKAS Research Station at Hawalbagh (ICAR), Almora involving three experiments. The Ist and IInd Experiment was laid out at VPKAS (ICAR), Almora during 1999-2001, involving 27 maize genotypes and 38 inbreds, respectively. Where as IIIrd Experiment was conducted at Banaras Hindu University, Varanasi and Nagenahalli, Mandya, Karnataka, during 2010-2011, which included 54 inbreds. The details of materials used and method employed in the three experiments were as follows.

Ist Experiment

In this experiment 27 entries involving 15 open pollinated varieties and composites, 4 narrow based synthetics and 8 Pools and Population were included for screening. The experiment was conducted at VPKAS (ICAR) Research Station at Hawalbagh during *Kharif* 1999 and *Kharif 2000* in RBD with two replication and plot size of 3.0 m x 1.8 m each involving 27 entries including local check 'Dhiari Local'.

IInd Experiment

The II experiment helped in screening of 38 inbred lines at

VPKAS research station at Hawalbagh during *Kharif* 2000 and 2001 under artificial epiphytotic field as well as in glass house conditions. The 38 genotypes were screened for 2 years at field condition and for 1 year in the glass house. In field condition the entries were evaluated in 3-row plot of 3.0 m x 1.8 m each and a local susceptible variety Dhiari Local was planted at regular interval as infector row in RBD with two replications. In addition, it was also planted in glass house conditions with five plants of each of 38 genotypes in pots during *Kharif* 2001. The data recorded is the average of the 3 trials.

IIIrd Experiment

Another experiment involving 54 inbreds were evaluated for identification of resistance sources in two environments at Agriculture Research Farm, Institute Agricultural Sciences, BHU, Varanasi and Zonal Agriculture Research Station, V.C. Farm, Mandya (Nagenahalli), Karnataka during 2010 and 2011. In field conditions, the entries were evaluated in 3-rows plot of 3.0 m x 1.8 m each and a local susceptible variety was planted at regular interval as infector row in RBD with two replications.

Inoculation

For purpose of inoculation about an inch layer of sorghum grains (nearly 40 to 45 g) was dispensed in a conical flask (500 ml), soaked in water for about 3-4 hours and excess water was drained off. The flask containing sorghum grains was autoclaved twice, seeded with fungus under aseptic condition and kept for incubation at 25-27ºC. The flasks were shaken once in 2-3 days to facilitate uniform growth on grains. After incubation of about a fortnight the material was ready for inoculation (Fig. 1).

Inoculum multiplication on Inoculum in powder form Sorghum grains

Creation of artificial inoculation

Figure 1: Inoculation Procedure

The impregnated sorghum grains were allowed for drying by spreading them on a clean paper sheet in shade at room temperature and a fine powder of these grains were prepared. The inoculums was directed into the leaf whorl of the plant followed by spraying 10-12 ml of water in the whorls by means of sprayer so as to maintain adequate moisture for longer period to permit spore germination. Inoculation was done in late afternoon (3-6 PM) to avoid the maximum day temperature during incubation period. The plants were inoculated with disease inoculum after 25 days (5-6 leaves stage) of planting and followed by two additional sprays of inoculums at 7-8 days interval (Shekhar and Kumar 2012). Disease symptoms developed with in 1-2 weeks of inoculum and by the time of flowering, the disease were severe in the infector rows. The same procedure was followed in all the 3 Experiments.

Disease Score

The scale consists of five broad categories designated by numerals from 1 to 5. Intermediate ratings between two numerals (1.5, 2.5, 3.5 etc.) have also been given, thereby providing for a total of nine classes or categories. Wherever possible, observations on lesion types can also be made, such as large sporulating wilt type or small chlorotic, non-sporulating type. Data was recorded 30-35 days after inoculation, then on flowering and finally just before dough stage. The disease scoring (Payak and Sharma 1985) was done as per symptoms mentioned below:

Very slight to slight infection, one or two to few scattered lesions on lower leaves. Light infection, moderate number of lesions on lower leaves only. Moderate infection, abundant lesions are on lower leaves, few on middle leaves. Heavy infection, lesions are abundant on lower and middle leaves, extending to upper leaves. Very heavy infection, lesions abundant on almost all leaves plants prematurely dry or killed by the disease.

RESULTS AND DISCUSSION

A total of 119 maize genotypes involving 92 maize inbreds, 27 pool, population, synthetics and open pollinated varieties were screened to identify additional sources of resistance for *'Maydis Leaf Blight'* (Fig. 2). These maize genotypes were collected from Directorate of Maize Research, New Delhi; VPKAS, Almora; CIMMYT Mexico; Private Companies, BHU, Varanasi, other public sector systems, etc..

Figure 2: Plant susceptible to MLB

Table 1: Screening of Pool, Population and other genotypes for identification of Additional Sources of *'Maydis Leaf Blight'* at VPKAS, Almora during 1999 and 2000

Pool, population and other genotypes	
Resistant	Vivek Sankul Makka 11, Syn-I, Syn-II, U 15-1, CM 502, VL Makka 88, VL Amber Popcorn, Population 31
Moderately Resistant	VL Pool-1, VL Pool 2, Early Heterotic Pool-I, Early Heterotic Pool-II, Pool 39, HEY Pool, Kiran, VL Makka-16, VL Makka-41, VL 87, VL 90, VL 78, VL 15, VL 89, U19
Susceptible	VL Pool 3, Surya, Navjot
Highly Susceptible	Dhiari Local

Table 2: Screening of maize inbreds for identification of Additional Sources of *'Maydis Leaf Blight'* at VPKAS, Almora during 2000 and 2001

Inbred lines	
Resistant	V53, V 178, V 190, V 336, V 340, V 341, V 345, V 348, CM 104, CM 145
Moderately resistant	V 12, V 13, V 26, V 128, V 241, V 273, V 334, V 335, V 339, V 342, V 346, CM 105, CM 118, CM 119, CM 129, CM 141.
Susceptible	V 17, V25, V 198, V 324, V 338, V 350, CM 128
Highly Susceptible	V 49, CM 126, CM 127, CM 202, CM 212

Table 3: Screening of maize inbreds for identification of Additional Sources of *'Maydis Leaf Blight'* in two environments during 2010 and 2011

Inbred lines	
Resistant	CM-145, V-341, V-336, V-348, HKI-586, HUZM-81-1, HUZM-60, CML-192, HKI 1105, HUZM-211-1, HKI-PC-8, CML-150, HKI 193, CML-161, HUZM-53, HKI 323, HKI-164-4-(1-3)-2, HKI-1352-5-8-9, CML-395, 219-J, CML-172, HUZM-36, HKI-536
Moderately Resistant	HUZM-88, HUZM-47, HUZM-97-1-2, CML-451, HKI-287, V-342, CML-140, V-273, HUZM-356, HKI-209
Susceptible	HUZM-457, V-346, V-335, HUZM-185, HKI-536, CM-141, V-338, HKI-335, V-386, V-388, HUZM-478, HUZM-509, HUZM-69, CML-152
Highly Susceptible	V-351, V-25, HKI-162, HUZM-80-1, CM-212, HUZM-121, CM-126

Table 4: Reaction of important maize gene pools and populations available at Almora against Southern Corn Leaf Blight (*Bipolaris maydis*)

S. No.	Sources	No. of genotypes Resistant	Moderate Resistant	Susceptible	Highly Susceptible
1	Vivekananda Population	4	14	6	6
2	Indian Public Sector	12	8	5	2
3	CIMMYT Mexico	7	6	3	0
4	Population 31	10	1	1	0
5	Exotic	2	7	3	3
6	Private Sector	1	1	1	0
7	BHU, Varanasi	5	4	5	2
8	Total	41	41	24	13

Ist Experiment

This experiment evaluated all the non-inbred genotypes involving 15 open pollinated varieties, 4 narrow based synthetics and 8 pools and population as mentioned in the Table 1. In this screening, 27 genotypes were evaluated consecutively for two years during 1999 and 2000 at Agriculture Research Farm, Hawalbagh, VPKAS (ICAR), Almora. The genotypes Vivek Sankul Makka 11, Syn-I, Syn-II, U 15-1, CM 502, VL Makka 88, VL Amber Popcorn and Population 31 were classified as highly resistant genotypes as they scored between 1-2 disease score during screening, while Dhiari Local was classified as most susceptible maize variety.

Out of 27 maize cultivars, 8 were screened as highly resistance, 15 were screened as moderately resistant whereas 3 cultivars were susceptible and 1 cultivar was highly susceptible. Amber popcorn, a popcorn composite was highly resistant wereas 2 sweet corn composite VL 78 and VL 15 and 2 baby corn composites VL87 and VL 90 were placed in moderately resistant category.

IInd Experiment

This experiment was conducted at Agriculture Research Farm, Hawalbagh, VPKAS (ICAR), Almora involving exclusively 38 inbred lines from Directorate of Maize Research, New Delhi; VPKAS Almora; CIMMYT Mexico and Private Companies.

This experiment was conducted consecutively for two years during 2000 and 2001 in the field under artificial epiphytotic conditions, whereas for one year during *Kharif* 2001 it was also screened under glass house conditions. Ten inbreds sources *viz*. V53, V 178, V 190, V 336, V 340, V 341, V 345, V 348, CM 104 and CM 145 were identified as resistant, as they scored between 1-2 disease score, whereas the inbred line *viz*., V 49, CM 126, CM 127, CM 202 and CM 212 were classified as susceptible lines as they scored above 3.5 disease score. The results of glass house as well as in field condition indicated similar trends. The result presented in Table 2 is the average of field as well as glass house experiment. With this experiment, 38 maize inbred lines were classified as having 10 resistance lines by scoring below 2 disease score, whereas

16 moderately resistant inbreds were identify by scoring disease score between 2 - 2.5 while 12 cultivars (V 17, V25, V 198, V 324, V 338, V 350, CM 128, V 49, CM 126, CM 127, CM 202, CM 212) as indicated in Table 2 were classified as susceptible and highly susceptible with disease score 2.5 - 4.0.

IIIrd Experiment

Fifty four maize inbreds were evaluated for two years and in two environments. The results of screening against '*Maydis Leaf Blight*' has been presented in Table 3. The IIIrd Experiment included 13 inbreds (CM-145, CM-141, CM-212, CM-126, V-341, V-336, V-348, V-342, V-273, V-346, V-335**,** V-338 and V-25) which were also tested in the IInd Experiment at VPKAS, Almora. The screening led to the identification of 23 sources of resistance *viz.*, CM-145, V-341, V-336, V-348, HKI-586, HUZM-81-1, HUZM-60, CML-192, HKI 1105, HUZM-211-1, HKI-PC-8, CML-150, HKI 193, CML-161, HUZM-53, HKI 323, HKI-164-4-(1-3)-2, HKI-1352-5-8-9, CML-395, HUZM-88219-J, CML-172, HUZM-36 and HKI-536. The lines such as CM-145, V-341, V-336 and V-348 which were resistant in IInd Experiment were also classified as resistant in this experiment, thus indicating wide adaptability for resistance to '*Maydis Leaf Blight*'. The lines V 53, V 178, V 190, V 340, V 345 and CM 104 exhibiting resistant were classified as partial resistance in IInd Experiment. These are the valuable material as it expressed resistance across the environment. Similar screening have been done for Southern Corn of Blight by Farhan Ali *et al.* (2012) and Durrishahwar *et al.* (2008) where as many studies have been carried out in past for other diseases like Northern Corn Leaf Blight (Singh *et al.* 2004, Muiru *et al.* 2007, Adipala *et al.* 1993, Chandrashekara *et al.* 2012, Muriithi and Mutinda 2001) and Grey leaf spot disease (Saghai Maroof *et al.* 1993).

These are studies, which aims at screening and identification of new and additional sources of resistance for various disease of maize. The present study also aims at similar results.

Based on susceptible and resistant reactions of maize genotypes, an attempt was made to identify the resistant gene pool sources for the disease. It was observed that CIMMYT Population 31 and Indian public sector was a very good source for breeding resistant cultivars. The other important sources were exotic materials obtained from CIMMYT and USA (Table 4). It may be mentioned here that the Indian public sector material majority coming from Directorate of Maize Research, New Delhi or its network have been generated out of CIMMYT and US, materials. Thus, the CIMMYT and US have contributed tremendously for the development of resistant cultivars for '*Maydis Leaf Blight*' in Indian Maize Breeding Programme. This should be the continuous effort as suggested by Singh and Singh, 2002. They have also identified approximately 65 Pathogens NCLB and SCLB which are the important diseases and causes heavy annual losses.

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