

Original Research Article

Screening of inbred lines of Maize against Turcicum Leaf Blight(*Exserohilum turcicum*) under artificial epiphytotic conditions

ABSTRACT:

Aims : Turcicum Leaf Blight (TLB) caused by *Exserohilum turcicum* is a major foliar disease of maize in Karnataka with yield losses up to 70% under severe cases. In the context of developing tolerant genotypes against this disease an experiment was conducted using 100 inbred lines which is collected from IMIC maize field day, Hyderabad.

Study design : Investigation was carried using Randomized-Block complete block design with two replication.

Place and Duration of Study: Maize Research Centre and Seed Farm, Devihosur during kharif-2022.

Methodology: These 100 lines were screened against TLB disease among them 10 resistant lines were selected based on their disease reaction, grain yield and per se performance and were crossed these lines in 10 X 10 half-diallel fashion to produce 45 experimental hybrids. These hybrids along with the parents were sown in Kharif 2023 at Maize Research Centre and Seed Farm Devihosur, UAS, Dharwad to study the disease reaction against TLB. Disease reaction was recorded by using 1 to 9 scale of Indian Institute of Maize Research, Ludhiana (Anon., 2016).

Results: The lines showing disease score between 1.0–3.0 will be considered as resistant (R), 4-5 as moderately resistant (MR), 6-7 as moderately susceptible (MS), 8-9 as susceptible (S). The performance of these lines and hybrids were compared with the resistant check CI-4 and susceptible check CM-202. Artificial inoculation was done in the leaf whorls with grounded TLB infected leaves at 45 days after sowing and were scored at silk drying stage. Screening trial revealed that 18 lines showed highly resistant reaction. This information can be useful for selection of parents and to develop tolerant hybrids in breeding programs or utilize them as source of resistance.

Keywords: TLB, Single Cross Hybrids, Artificial inoculation, Resistance, Tolerance

1. Introduction:

Maize (*Zea mays L.*) is an important crop globally due to its high yield potential and serves as food, feed and provides raw materials for agro-allied industries in the world. In India, it is the third important cereal after wheat and rice in terms of area and production. The global average productivity of maize is 5.8 t/ha and India's productivity is 3.38 t/ha. In Karnataka, maize occupies an area of 1.59 mha, with the production of 5.22 mt and average productivity is 3.27 t/ha (Annual Progress Report, *Kharif* maize, 2023, AICRP on maize). Despite its high yield potential, one of the major limiting factors to maize grain yield is its sensitivity to several diseases. Approximately 65 pathogens infect maize. Turcicum Leaf Blight (TLB) caused by *Exserohilum turcicum* is one of the major foliar diseases in maize causing more than 50% yield loss in severe cases in Karnataka. Due to moderate low temperature and high humidity during the maize growing period, TLB has become a major disease.

TLB occurs sporadically in humid areas where maize is grown. TLB causes leaf necrosis and premature death of foliage which reduces the fodder and grain value of the crop. In India the disease is prevalent in the states of Karnataka, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Orissa, Andhra Pradesh and North Eastern Hill states. It also affects the Rabi maize in the plains of India. TLB is endemic in all maize growing areas and considered as a limiting biotic factor for successful cultivation of maize, which results in significant yield losses in the range of 28 to 91 per cent (Pant *et al.*, 2000). TLB caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs, is known to infect maize from the seedling stage to maturity. The symptoms first start as small elliptical spots on the leaves as grayish green with water-soaked lesions parallel to leaf margins, the spots turn grayish with age and increase in size, finally attaining a spindle shape with long elliptical grayish or tan lesions. If the disease starts at an early stage, it causes premature death of the blighted leaves. As a result, the crop loses their nutritive value as fodder (Payak and Renfro, 1968), having reduced germination capacity, vigor,

Grain yield and total sugar content (Ferguson and Carson, 2004) have restricted starch formation, chaffy kernels and infected plants are liable to infection with stalk rots (Henry and Kettlewell, 1996). The fungus has a wide host range and a high pathogenic variability with several races already reported in different parts of the world (The genetics of resistance is determined in most of maize genotypes quantitatively and has been used for control of this disease. Resistance was reported to be partially dominant and controlled by many genes (Vanderplank, 1963). Although the losses due to these diseases can be minimized by foliar application of fungicides, the most appropriate and economical strategy is to use host plant resistance and resistance breeding programs. In this context an experiment was designed to identify new hybrids and sources of resistance against *Turicum Leaf Blight* for future use in maize breeding program..

2. Materials and Methods

In the context of screening tolerant genotypes against this disease an experiment was conducted using 100 inbred lines. Among them 10 lines were selected based on their disease reaction, test weight and per se performance. These lines were crossed in 10 X 10 half diallel fashion to produce 45 single cross hybrids. These hybrids along with the parents were sown in Kharif 2023 at Maize Research Centre and Seed Farm Devihosur, UAS, Dharwad (Northern transition zone (Zone VIII) of Karnataka) to study the disease reaction against TLB. This location has been identified as one of the hotspots for TLB incidence (Harlapur *et al.*, 2007). The performance of these lines and hybrids were compared with the resistant check CI-4 and susceptible check CM-202. Along with these three checks; GH-0727, 900 M Gold and NK-6240 were also evaluated as a comparison with the developed hybrids.

2.1 Inoculation of pathogen on host :

Artificial inoculation was done by collecting heavily infected leaves collected from the previous season. These infected leaves were stored in large gunny bags in dry conditions protected from moisture and rodents. Pure culture of fungus was prepared by using Hyphal isolation procedure and multiplication is done using Sorghum grain.

Inoculation was done at 45 days of sowing (when plant attains the height of 30-45 cm) by placing a pinch of leaf meal into whorl of each plant. In order to counteract the prevailing dry weather, water was applied in the whorls by means of sprayer (high humid weather is congenial for the establishment and disease spread).

Comment [sp1]: Inoculation procedure references should be given

2.2 Evaluation and recording of disease reaction

The scale consists of five broad categories designated by numerals from 1 to 9 (Indian Institute of Maize Research, Ludhiana). Scoring was done at silk drying stage of the plant. The classification has been given in Table.2.

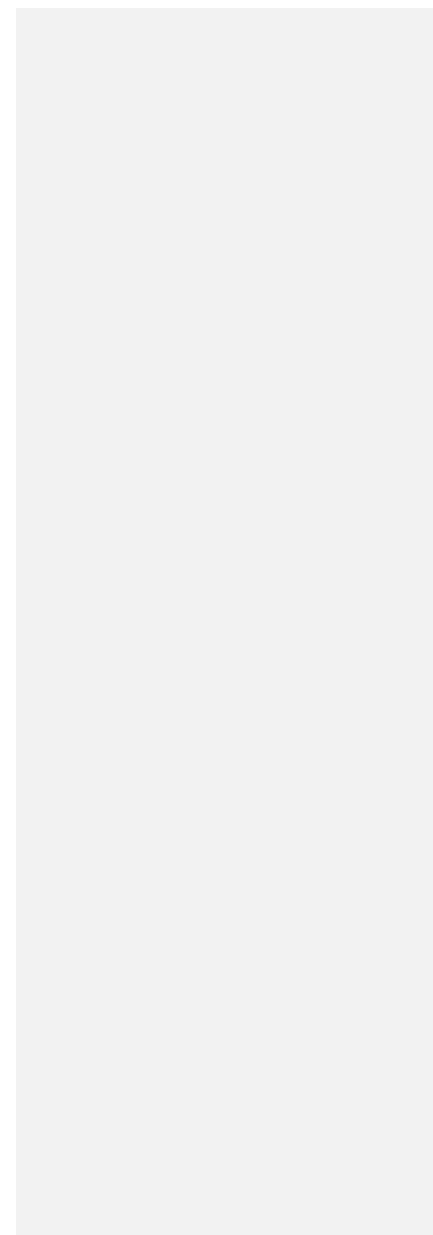
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Table1.List ofMaizeinbred linesusedforScreening againstTurcicumleafblight during Kharif-2022

SL. NO	INBRED LINE	PEDIGREE/SOURCEPOPULATION	SL. NO	INBRED LINE	PEDIGREE/SOURCEPOPULATION
1	VL19978	HYDTSyn16HG(A)-8-2-1-B-B1-BB	26	VL185877	((CAL1821/CML165-B*9)-B)DH126-BB
2	VL191001	HYDTSyn16HG(B)-10-1-1-B-B1-8	27	VL184659	CML581/CML161X165-16-2-1-B*8)HB)DH12-BB
3	VL20300	SUWANI(5)C9#-9-1-B1-B	28	VL184725	((CML581/CML161X165-16-2-1-B*8)DH78-BB
4	VL18775	CL02450-B5/G9BCORL23-1P-2P-3-2P-3G9BCORL34-2P-IP-1-1-1)7-1-3-3-2-1-B*8)B-2-BB-B1-B	29	VL184560	((CML581/CML165-B*9)-B)DH44-BB
5	VL18246	(ICMLAS1/OF67//CML451)-12 B*5/Composite4)-B-B2-1-B(DM)-BBB-B2-B	30	VL184578	((CML581/CML165-B*9)-B)DH62-BB
6	VL20157	(Composite15-BBB-1-B-1-B-BICTS013008/AMATLCOHS71-1-1-2-1-1-1-HY:B5/Nei402020)-B 12)-B-24-B-BI-B	31	VL184076	(CML581/CML161X165-16-2-1B*8/CML581)DH106-BB
7	VL20160	Composite15-BBB-1-B-1-B-#BCA14517/P145CAMH7-1-B-1-1-B-1-1B-17-1-B-22-B-B1-BB	32	VL183975	CML581/CML161X165-16-2-1B*8//CML581)DH5-BB
8	VL143905	CML444/VL111354)-38-B-4-BB-4-85	33	VL184330	CML582/CML165-B*9//CML582)DH5-BB
9	VL107657	85(CML474/S92145-2EV-7-3-B5)-F2-58-19V1825-6	34	VL1010960	PHG47-BBB-#-B
10	VL1016532	CML161X165-16-2-1-B13	35	KL141702	PHR63-BBB-#-B
11	VL21943	CL106712/LH195)-B/CLHP0003)-B-6-1-11-BBB	36	KL20264	P73TLC3#-111-2-4-##-BB)x(RCW01)]-1150-B4/(CML474/S92145-2EV-7-3-B*5)-F225-1-B11/[(P73TLC3#-111-2-4-##BB)x(RCW01)]-1-150-B5)-B-5(0)-B(DM)B1-BBB
12	VL181619	(CL106728/LH213)-B/CML575)-B-6-3-1-1-1BBB	37	VL20269	HYDTSyn16HG(A)-1-1-2(DM)-B1-BBB
13	VL21952	(CML31/2FADB//CML486))DH0-46-B8	38	VL18720	((CML465/CML165-B//CML465)-BB-36 B*5/(CML161xCML451)-B-18-1BBB/CML161-B)-B-13-BB(NonQ)-BBB-B1)B-3-B-B1-B
14	VL181565	((CMLS22/PHN82)-B/CML551)-B-6-3-1-1-1BBB	39	VL18722	(CML465/CML165-B//CML465)-BB-36B*5/(CML161xCML451)-B-18-1BBB/CML161-B)-B-13-BB(NonQ)-BBB-B1)B-6-B-B1-B
15	VL181675	((CMLS22/PHN82)-B/CML551)-B-6-8-1-1-1BBB	40	VL18718	CML466/CML165-B//CML466)-BB-9B*4/(CML465/CML165-B//CML465)-BB-36B*5)-B-10-B-BI-B
16	VL21968	((CML539/2FADB//CML486))DH0-7-B*7	41	VL18686	(CML466/CML165-B//CML466)-BB-9B*4/(CML465/CML165-B//CML465)-BB-36-HY2B*S)-B-3-BBB
17	VL21969	((CML545/PHHB9)-B/CML496)-B-81-2-1-1BBB	42	VL18716	((CML466/CML165-B//CML466)-BB-9B*4/(CML465/CML165-B//CML465)-BB-36-HYZB*5)-B-8-B-B1-B
18	VL181580	((CML78/PHG39)-B/CML486)-B-6-3-1-1-1BBB	43	VL18726	[(P73TLC3#-111-2-4-##-BB)x(RCW01)]-1150-B*4/(CML474/S92145-2EV-7-3-B*5)-F2-HY 58-1-B*12)-B-2-B-B1-B1
19	VL21976	CL106941/PHR03//CML451)-7-2-1-1-1-B*4	44	VL18727	[(P73TLC3#-111-2-4-##-BB)x(RCW01)]-1150-B*4/(CML474/S92145-2EV-7-3-B*5)-F258-1-B*12)-B-3-B-B1-B
20	VL21978	CML311/2FADB//CML486)-89-1-1-1-1-B*5	45	VL18729	[CML327xCML287]F2-32-1-B*5-1B*10/[(P73TLC3#-111-2-4-##BB)x(RCW01)]-1-150-B*4)-B-3-B-B1-B
21	VL21980	CML519/LH213//CML323)-9-3-1-1-1-B*4	46	VL18911	(CL02450 B*5/(CLRCY015/[CML373xCML361]-BB-2-EBBB)-B*4-1)-B-4-B-B1-B
22	VL21988	SUWANDMR-C3-35-1-1-1-1-1-B*4	47	VL18901	CL02450 B*5/(CLRCY015/[CML373xCML361]-BB-2BBB)-B*4-1)-B-5-1-BB
23	VL21989	SUWANDMR-C3-43-1-1-1-0-1-B*4	48	VL18914	CL02450 B*5/(CLRCY015/[CML373xCML361]-BB-2BBB)-B*4-1)-B-5-3-B1-B

24	VL21990	SUWANDMR-C3-54-1-1-1-1-B*4	49	VL18896	(CML451-B*7/((CLA37/CLA42)-BBB40/CLA18)-B*4-1)-B-2-BBB
25	VL185586	(((CLQ-RCYQ31xCLQ-RCYQ35)-B-36-2*4/CML581)-B)DH31-BB	50	VL18909	CML581/CML161X165-16-2-1B*8/CML581)DH5-BB

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SL. NO	INBRED LINE	PEDIGREE/SOURCE POPULATION	SL. NO	INBRED LINE	PEDIGREE/SOURCE POPULATION
51	VL18910	(CML451-B*7/PobSA3-106-BBB-5)-B-4-BB1-B	76	VL2088	GS13C2F2-40-BB-B1-BB
52	VL22280	CA34505xCA00302)-B-2-1-B-1-BB(T)-BS<#17-3-B-2-B*5/(LaPostaSeqC7-F64-2-7-2-1B*4/LaPostaSeqC7-F55-2-2-2-1-B*5)-18BBB-#-B/(CA34505xCA00302)-B-2-1-B-1-BB(T)-B5-#17-3-B-2-B*5/PHG39-BB)-B-1BB	77	VL109452	(CLQ-6601xCL-02843)-B-26-3-1-BB-2-B*81-B4
53	VL22282	(CA34505xCA00302)-B-2-1-B-1-BB(T)-B5#17-3-B-2-B*5/(LaPostaSeqC7-F64-2-7-2-1B*4/LaPostaSeqC7-F55-2-2-2-1-B*5)-18BBB-#-B/(CA34505xCA00302)-B-2-1-B-1-BB(T)-B5-#17-3-B-2-B*5/PHG39-BB)-B-12B1-B	78	VL143915	(VL111354/CML472)-7-B-1-B*4-#-B2-B
54	VL22292	CML165/OFP9/CML165)-7-B*5-3BBB/Composite18-B(Fat)-BB-3-BBB)-B-1BB	79	ZL19359	MPS-1-C2GS)DH16-BBB-B1
55	VL22297	(CML563/POB45c9F22-18-3-1-B*4-1-B*8-#B)-B-7-BB	80	ZL19467	(MPS-2-C1)DH17-B*4
56	VL22301	(CML563-B/(CML466/CML165-B/CML466)BB-11-B*6-B1)-B-8-BB	81	ZL19634	MPS-2-C3GS)DH73-B*4
57	VL22303	CML466/CML165-B/CML466)DUALCAMERAS-B1)-B-12-BB	82	ZL153633	EYSyn-A-#-27-#-B-2-BB-BI-#-1-B
58	VL22306	(CML451-B*7/PobSA3-106-BBB-5)-B-4-BB1-B	83	ZL155281	((Pop61CIQPMTEYF-40-1-1-1-2-B1/(CML161xCML451)-B-23-1-B*4-1)-B-5BB/G18SeqC5F19-1-2-1-2-4-B*5)DH35-B-#1-B
59	VL22308	((CA34505xCA00302)-B-2-1-B-1-BB(T)-B5#17-3-B-2-B*4/CML582/(CA34505xCA00302)-B-2-1-B1-BB(T)-B5-#17-3-B-2-B*5)-B-6-BB	84	ZL155285	Pop61CIQPMTEYF-40-1-1-1-2-B1/(CML161xCML451)-B-23-1-B*4-1)-B-5BB/G18SeqC5F19-1-2-1-2-4-B*5)DH42-B-#B
60	VL22310	CA34505xCA00302)-B-2-1-B-1-BB(T)-B5-#17-3-BB*4/CMLS82/(CA34505xCA00302)-B-2-1-B1-BB(T)-B5-#17-3-B-2-B*5)-B-11-BB	85	ZL17518	(HSBC1F1-3)DH75-B-#-BB
61	VL22319	((CML161xCML451)-B-18-1-BBB/CML161B)-B-13-BB(NomQ)-BBB-B1 CML465/CML165-B/CML465)-B-15B1-B5)-B-9-BB	86	ZL17578	HSBC1F1-4)DH2-B-#-BB
62	VL22324	(CA03147-B*8-1/CA00360F2-3-5-6-1-B*11#-B)-B-6-BB	87	CAL1733	WLCY2-7-1-2-1-5-B-2-3-1-2-2-B*8-#-B2-B
63	VL22326	(CL02450-B*6-#CML452-Ac8328BNC6166-1-1-1-B*15-#)-B-2-BB	88	CAL14137	WLCY2-7-1-2-1-5-B-2-2-2-2-1-B*9-#-B2-BH
64	VL22336	CML563/(POP501C5#8/GEMS-0039)-B-101-1-1-BB)-B-15-BB	89	ZL18910	G18SeqC5F19-1-2-1-2-4BB/CL02450)DH18-B*4
65	VL22337	CML563/(POP501C5#8/GEMS-0039)-B-101-1-1-BB)-B-27-BB	90	ZL19872	MPS-5-C1)DH62-B*4
66	VL22344	Composite15-BBB-1-B-1-B-# B/(CTS013004/AMATLCOHS71-1-1-2-1-1-1-HYB*5/Ki45)-B*6)-B-16-BB	91	ZL19611	MPS-2-C3GS)DH47-BBB
67	VL22345	(Composite15-BBB-1-B-1-B-#B/(CTS013008/AMATLCOHS71-1-1-2-1-1-1-HYB*5/Nei402020)-B*12)-B-15-BB	92	VL181418	CML566-B
68	VL22346	(Composite15-BBB-1-B-1-B-#B/(CTS013008/AMATLCOHS71-1-1-2-1-1-1-HYB*5/Nei402020)-B*12)-B-4-BB	93	VL21943	CML608B-B
69	VL22347	(Composite15-BBB-1-B-1-B-#CA14517/P145C4MH7-1-B-1-1-B-1-B*17-1)-B-7-BB	94	VL101361 2	(CLG2309x(((P390bcoC3F191-1-1-1-4 B*4)x(P73TLC3#-96-3-4-#)]-2-2-3))-1-29-1-F153(((P390bcoC3F191-1-1-1-4-B*4)x(P73TLC3#115-1-4-#))-1-2-8)xRCW01]-1-167-BB-1BBB
70	VL22350	(CML444/VL111354)-42-B-#-B14-B	95	VL108153	(CAL1533/CML571)-BB-2-B2-BBB
71	VL22351	(CML444/VL111354)-42-B-#-B15-B	96	VL2084	CAL191/(Composite15)-B-11-BBB)-BB-17B2-BBB
72	VL18580	(CML451-B*4/CML451BBB/LaPostaSeqC7-F18-3-2-2-3B*7//CML451-B*4/CML451-BBB/DRB-F260-1-1-1-BBB-3-B)-BB/(ATZTRLBA905-3-3P-1P-4P-2P-1-1-1-B/G9BCORL23-1P-2P-32P-3-2P-1P-BBB)-B-57TL-2-1-1-B*5)-B-3	97	VL2061	GS14C2F2-19-BB-B1-BBB
73	VL18670	((CA34505xCA00302)-B-2-1-B-1B(T)ZEWBC1F2-216-2-2-2-B*4-1-B-1-BBB)-B-B1-B-5-BB1-B1-B	98	VL2090	(Composite15)-B-11-B-#-B11-B
74	VL16229 1	AMDROUT2e3-B-4-B(DM)-BB-B1-2-B-B1	99	VL191090	(Composite15)-B-11-B-#-B12-B

75	VL2049	((Composite15)-B-11BBB/(CML466/CML165-B//CML466)-BB-11HY21R-YB*4,-BB-8-B1-B	100	VL191093	(Composite15)-B-11-B-#-B14-B
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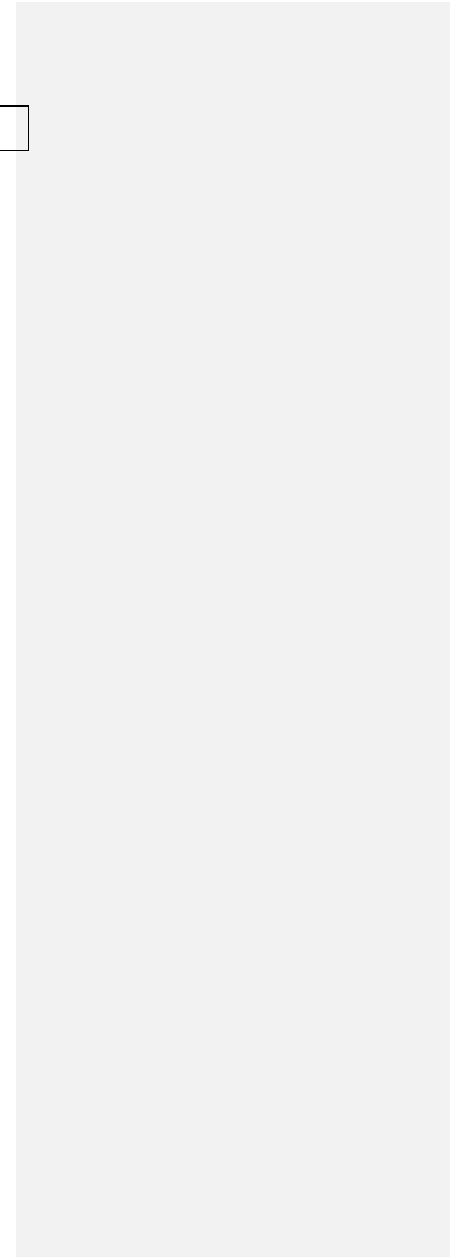


Table 2: Diseases scale for Turicum leaf blight (TLB) in maize

Rating Scale	Degree of infection (percent DLA)	Disease reaction
1.0	Nil to very slight infection (<10%)	Resistant (R) (Score: ≤3.0) (PDI: ≤33.33)
2.0	Slight infection, a few lesions scattered on two lower leaves (10.1-20%).	
3.0	Light infection, moderate number of lesions scattered on four lower leaves (20.1-30%).	
4.0	Light infection, moderate number of lesions scattered on lower leaves, a few lesions scattered on middle leaves below the cob (30.1-40%).	Moderately resistant (MR) (Score: 3.1-5.0) (PDI: 33.34-55.55)
5.0	Moderate infection, abundant number of lesions scattered on lower leaves, moderate number of lesions scattered on middle leaves below the cob (40.1-50%).	
6.0	Heavy infection, abundant number of lesions scattered on lower leaves, moderate infection on middle leaves and a few lesions on two leaves above the cob (50.1-60%).	Moderately susceptible (MS) (Score: 5.1-7.0) (PDI: 55.56-77.77)
7.0	Heavy infection, abundant number of lesions scattered on lower and middle leaves and moderate number of lesions on two to four leaves above the cob (60.1-70%).	
8.0	Very heavy infection, lesions abundant scattered on lower and middle leaves and spreading up to the flag leaf (70.1-80%).	Susceptible (S) (Score: >7.0) (PDI: >77.77)
9.0	Very heavy infection, lesions abundant scattered on almost all the leaves, plant prematurely dried and killed (>80%).	

3.1 Result and discussion

Continuous efforts to locate the resistant source and utilization in resistant breeding programme are imperative to manage the disease in long run. Disease reaction indicated satisfactory level of disease development and thereby the classification into different classes was appropriate and easier. The screening trial has revealed that out of the 100 lines were screened for TLB, 18 lines showed highly resistant reaction, 39 showed moderately resistant reaction, 44 lines showed moderately susceptible reaction and 7 lines showed susceptible reaction.

List 1 : LIST OF INBRED LINES

GROUP	SOURCE	INBRED LINES
Resistant	1-3	VL21943, VL20300, VL18167, VL21988, VL21989, VL18397, KL20264, VL18718, VL18727, VL18914, VL22297, VL22347, VL20840, VL20900, VL14390, VL10765, VL18587, VL18407
Moderately resistant	4-5	VL19978, VL21952, VL21969, VL18896, VL19103, VL18911, VL22292, VL19100, VL21968, VL18558, VL18456, VL10109, VL18722, VL22282, VL22319, VL22337, VL10945, VL14391, ZL19634, ZL17518, VL18141, VL21943, VL21978, VL21980, VL21990, VL18465, VL18472, VL18729, VL18901, VL18909, VL18910, VL22301, VL22306, VL22345, VL22346, VL22350, VL16229, VL10136, VL19109
Moderately susceptible	6-7	VL18775, VL20157, VL18161, VL18158, VL21976, VL18457, VL18433, VL20269, VL22280, VL22310, VL22336, VL18580, VL18670, ZL19359, CAL14137, ZL18190, VL21943, VL20610, VL18246, KL14170, VL18720, VL18686, VL18716, VL18726, VL22303, VL22308, VL22324, VL22326, VL22351, ZL15528, CAL1733, ZL19872, ZL19611, VL22344
Susceptible	8-9	VL20160, VL18156, VL20490, VL20880, ZL15363, ZL17578, ZL19467, VL10815, ZL15528

Comment [sp2]: In discussion no references are given to support the result. At least 2-3 references must be given



Fig1: Resistant check CI-4 (left), Susceptible check CM-202 (right)

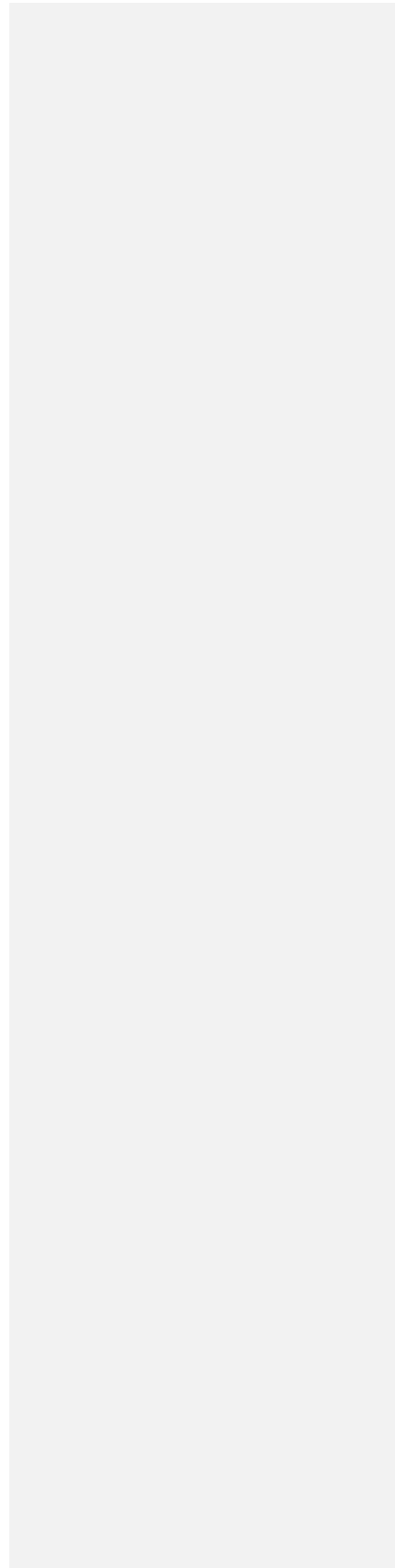




Fig2:Foliarsymptoms Turicumleafblight

4. CONCLUSION :

Continuous efforts to locate the resistant source and utilization in resistant breeding programme are imperative to manage the disease in long run. Disease reaction indicated satisfactory level of disease development. Screening of inbred lines and identifying best resistant lines plays a major role in hybrid breeding. This information is very useful in development of resistance and development of resistant hybrids.

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