academicJournals

Vol. 8(27), pp. 2592-2597, 2 July, 2014
DOI: 10.5897/AJMR2014.6708
Article Number: A523D5645843
ISSN 1996-0808

http://www.academicjournals.org/AJMR

African Journal of Microbiology Research

Full Length Research Paper

Disease reaction studies of maize (*Zea mays* L.) against turcicum leaf blight involving indigenously identified cytosterile source

A. Ishfaq[1], Z. A. Dar[2], A. A. Lone[2], G. Ali[2], A. Gazal[2], B. Hamid[3] and F. A. Mohiddin[3*]

[1]Directorate of Research, SKUAST-K, Shalimar, J&K- 190025, India.
[2]Division of Plant Breeding and Genetics, SKUAST-K, Shalimar, J&K- 190025, India.
[3]Division of Plant Pathology, SKUAST-K, Shalimar, J&K- 190025, India.

Received 12 February, 2014; Accepted 13 June, 2014

Among biotic stresses affecting maize, the turcicum leaf blight caused by *Exserohilum turcicum* is one of the most important diseases in India. Disease reaction studies against turcicum leaf blight were done with two crosses viz., 15C (A) x I-318 (R) and I-401(A) x I-318(R) for all six generations with P_1, P_2 and F_1 having 30 plants each and F_2 (300 plants), BC_1 (180 plants) and BC_2 (180 plants). Analysis of variance of arc sin transformed data for leaf blight in the present study revealed significant variability has been exhibited by fungus to infect different generations of a particular cross. In I-15C(A) x I-318(R) cross, F_1 was moderately resistant to turcicum leaf blight but F_1 of I-401(A) x I-318(R) cross was moderately susceptible to the disease. Disease screening of both crosses indicated that the latent period was longer, suggesting presence of resistant genes in both the crosses which further can be exploited in the production of successful commercial hybridsby using these CMS sources as parents to develop turcicum leaf blight (TLB) resistant, cost effective and stable hybrids.

Key words: Maize, *Zea mays* L., turcicum leaf blight, cytosterile source.

INTRODUCTION

Maize (*Zea mays* L.) holds a unique position in world agriculture as food, feed and source of diverse Industrially important products. Maize is cultivated on nearly 100 million hectares in developing countries and about 70% of the total maize production in developing world is from low and lower middle income countries (Faostat, 2010). In sub-Saharan Africa, it provides food and income to over 300 million households (Tefera et al., 2011).

Turcicum or northern corn leaf blight (NCLB) is a serious foliar wilt disease of maize in many tropical and temperate environments. NCLB is a severe fungal disease causing yield losses worldwide, is most effectively controlled by resistant varieties. Genomic prediction could greatly aid resistance breeding efforts (Frank et al., 2013). It is caused by the ascomycete fungus *Setosphaeriaturcica* (Luttrell) Leonard and Suggs, with its conidial state *Exserohilum turcicum* (Passerini)

*Corresponding author. E-mail: famohiddin@rediffmail.com.

Leonard and Suggs. Symptoms can range from small cigar shaped lesions to complete destruction of the foliage (Welz and Reiger, 2000). Turcicum leaf blight causes extensive defoliation during grain filling period, reduce succulence of leaves and stalk necrosis resulting in grain yield losses (Perkins and Pederson, 1987). The disease was reported as early as 1923 in India and assumed as an epiphytotic form in Kashmir valley (Koul, 1957). The disease is favoured by high humidity with moderate to high temperatures from three leaf stages to grain development of crop (Palaversic et al., 2012).Turcicum leaf blight disease in maize is particularly prevalent during *Kharief* (rainy) season in the Zones I, II and IV as delineated by the All India Coordinated Reseach Project (Maize), namely Peninsular, North eastern and Northern hill regions. Yield losses due to TLB worldwide can range from 27 to 90% in addition to predisposing plant to stalk rots and reducing forage value (Chenulu and Hora, 1962).

Turcicum leaf blight (TLB) is characterized by long elliptical, greyish green or tan leaf lesions that first appear on the lower leaves and increase in size and number until very little living tissue is left. Yield is reduced due to lack of carbohydrates for grain filling (Paliwal et al., 2000). Eight three-way and four commercial maize hybrids for yield and resistance to maize streak virus using controlled leaf hopper infestation and turcicum leaf blight under artificial inoculation was studied. The hybrid 053WH54 had multiple resistances to turcicum leaf blight and maize streak virus. The hybrids 043WH61 and 043WH07 were high-yielding even at high disease pressure while 043WH41 and 013WH03 were relatively low yielding at low disease pressure. This showed the inherent genetic diversity of the hybrids. The hybrids ZS 225, 043WH61 and 043WH07 are recommended for production in areas with high prevalence of both diseases (Karavina et al., 2014). The use of resistant cultivars is most effective, economical and environmental friendly means to control epidemics of turcicum leaf blight. Thus, in the present study, screening for TLB was carried out in all the six generations of both crosses viz., 15C (A) x I-318 (R) and I-401 (A) x I-318 (R).

MATERIALS AND METHODS

The material for study was developed by attempting the crosses 15C (A) x I-318 (R) and I-401 (A) x I-318 (R) during *kharif* 2010 to generate F_1 generation at High Altitude Rice Research Sub-station, Larnoo. The F_2 and backcrosses generation (BC_1 and BC_2) were developed at Winter Nursery Centre (ICAR) Hyderabad, during *rabi* 2010-11. All the six basic set of generations P_1, P_2, F_1, F_2, BC_1 and BC_2 and 15C (B), I-401 (B) and restorer R-line I-318 (R) of the crosses thus obtained were raised and screened for turcicum leaf blight.

Six generations of each cross were evaluated in randomized complete block design with three replications at the Experimental Farm of Division of Plant Breeding and Genetics, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar during *kharif* 2011. The nonsegregating (P_1, P_2 and F_1) and segregating generations (F_2, BC_1 and BC_2) were raised in four and six rows with inter and intra row spacing of 60 and 25 cm, respectively. Screening for disease was carried out with 30 plants each of P_1, P_2 and F_1 and 300 plants of F_2, 180 plants each from BC_1 and BC_2.The plants were inoculated artificially at 5-6 leaf stage with the conidial suspension of test fungus (*E. turcicum*) 4-5 x 10^4 conidia ml^{-1} (Figures 1, 2 and 4) in the evening hours and high humidity was maintained by spraying water 5-6 times in the next 3 days to ensure infection. All the leaves on infected plants were scored using 0-5 scale (Figure 3) adopted by maize pathology unit, CIMMYT as: 0 = no symptoms; 1 = one to few scattered lesions on leaves covering up to 10% leaf area; 2 = lesions on leaves covering 11-25% leaf area; 3 = lesions on leaves covering 26-50% leaf area; 4 = lesions abundant on leaves covering 51-75% leaf area; 5 = lesions abundant on almost all leaves, plants prematurely dried or killed with 76-100% leaf area covered.

The per cent disease incidence and severity were calculated in each observation as per the following formula:

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased leaves}}{\text{Total number of leaves assessed}} \times 100$$

$$\text{Disease Severity (\%)} = \frac{\text{Sum of all numerical ratings}}{\text{Number of leaves examined x maximum diseases rating}} \times 100$$

The data was arc sine transformed as recommended for data,

Figure 1. Conidial suspension of test suspension.

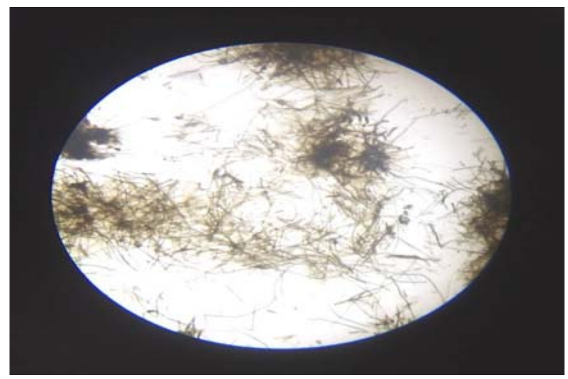

Figure 2. Microscopic view of conidial fungus of *E. turcicum*.

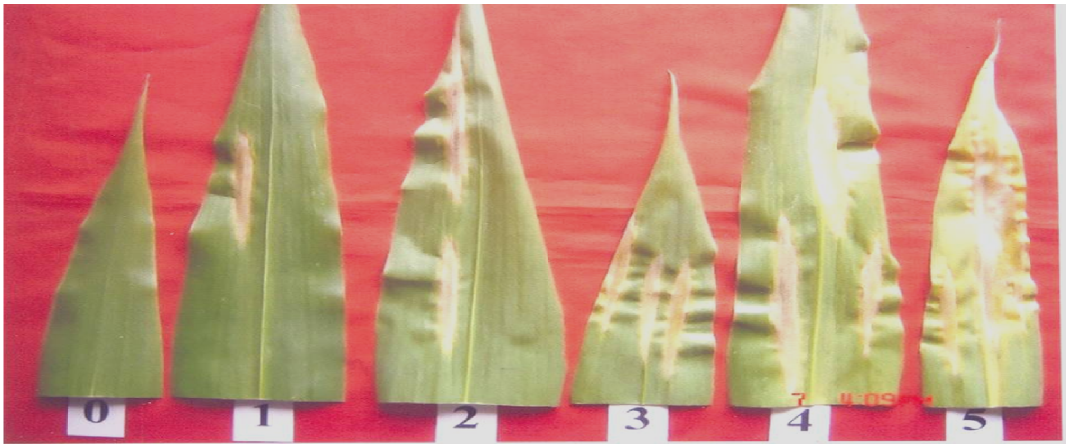

Figure 3. Scale (0-5) for assessment of Turcicum leaf blight intensity on maize.

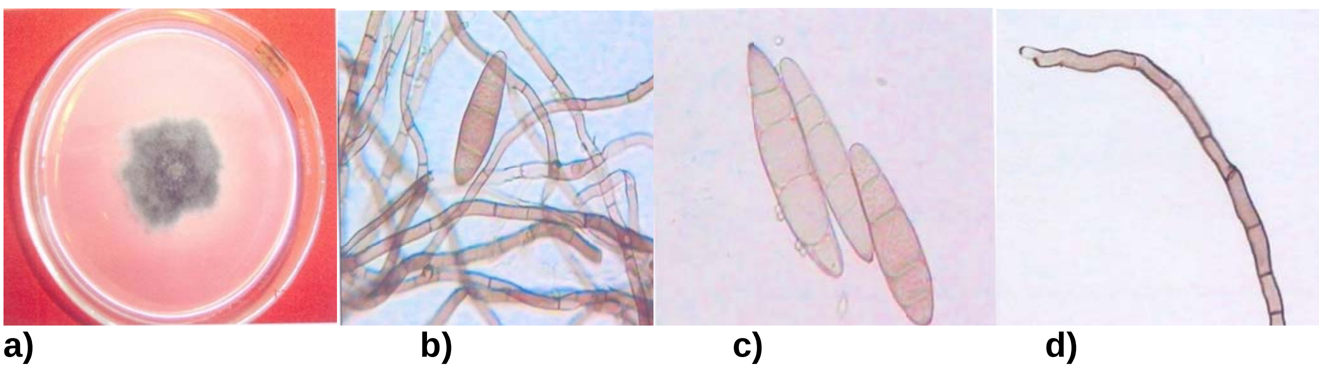

Figure 4. a) Mycelial colony of *E. turcicum*, b) mycelium of the fungus, c) conidia of the fungus, d) conidiophore with scarlet tip.

expressed as decimal fractions or percentages as per the procedure of Steel and Torrie (1980).

RESULTS AND DISCUSSION

Moderate to high disease pressure was achieved through artificial inoculations of conidial suspension of test fungus (*E. turcicum*) as was evident from the disease severity of the crosses. The six basic set of generations, P_1, P_2, F_1, F_2, BC_1 and BC_2 of two crosses viz., 15C (A) x I-318 (R) and I-401 (A) x I-318 (R) were evaluated by recording observations on percent disease incidence and percent disease severity following (0-5) scale as described in material and methods.

Transformation of the data by arc sine method (Steel and Torrie, 1980) was done and analysis of variance in transformed data for both the crosses is presented in Table 1. Significant differences among generations of both crosses were revealed suggesting presence of sufficient variability for prevalence of diseases.

Significant critical difference of 4.11 and 4.07 with respect to disease incidence and significant critical difference of 1.44 and 1.52 with respect to disease severity were observed in 15C (A) x I-318 (R) and I-401 (A) x I-318 (R) crosses for turcicum leaf blight. Responses of the two crosses viz., 15C (A) x I-318 (R) and I-401 (A) x I-318 (R) to TLB in the trial (*Kharief*2011) are shown in Figure 5.

Subsequently, six generations of the two crosses were grouped into categories as moderately resistant (MR) and moderately susceptible (MS). The F_1 of the cross 15C (A) x I-318 (R) was moderately resistant (MR) to turcicum leaf blight with mean disease incidence of 49.24% and severity of 23.52%. But in BC_2, mean disease severity was lower, 21.54% than both F_2 and BC_1. Contrary to this, in cross I-401 (A) x I-318 (R) F_1 was moderately susceptible (MS) with mean disease incidence of 56.72% and severity of 26.77% but again BC_2 showed lower mean disease severity of 22.54% than F_2 and BC_1 as revealed in Table 2.

Dominance nature of genes was exhibited in the cross 15C (A) x I-318 (R) as F_1 of the cross was moderately resistant (MR) whereas F_1 was moderately susceptible

Table 1. Analysis of variance for arc-sine transformed generation means for reaction to Turcicum leaf blight (*Exserohilum turcicum*) in two crosses I-15C(A) x I-318(R) and I-401(A) x I-318(R) of maize.

Cross : I-15C(A) x I-318(R) [Leaf blight incidence]						**Cross : I-401(A) x I-318(R) [Leaf blight incidence]**					
S.V	**D.F**	**S.S**	**M.S**	**F**	**P**	**S.V**	**D.F**	**S.S**	**M.S**	**F**	**P**
Rep.	3	2.56	0.85	0.11	0.95	Rep.	3	11.94	3.98	0.55	0.65
Treat.	5	842.88	168.58**	22.71	0.00	Treat.	5	1053.08	210.62**	28.86	0.00
Error	15	111.35	7.42			Error	15	109.47	7.30		
Total	23	956.78				Total	23	1174.49			
$S.E_{(diff.)}$ = 1.93; C.D = 4.11**						$S.E_{(diff.)}$ = 1.91; C.D = 4.07**					

Cross : I-15C(A) x I-318(R) [Leaf blight severity]						**Cross : I-401(A) x I-318(R) [Leaf blight severity]**					
S.V	D.F	S.S	M.S	F	P	S.V	D.F	S.S	M.S	F	P
Rep.	3	11.348	3.78	4.09	0.26	Rep.	3	0.922	0.307	0.52	0.672
Treat.	5	84.68	16.93**	18.32	0.000	Treat.	5	106.505	21.301**	36.34	0.00
Error	15	13.68	0.924			Error	15	8.792	0.586		
Total	23					Total	23	116.219			
$S.E_{(diff.)}$ = 0.679; C.D = 1.446**						$S.E_{(diff.)}$ = 0.541; C.D = 1.152**					

** = Significant at 5% level.

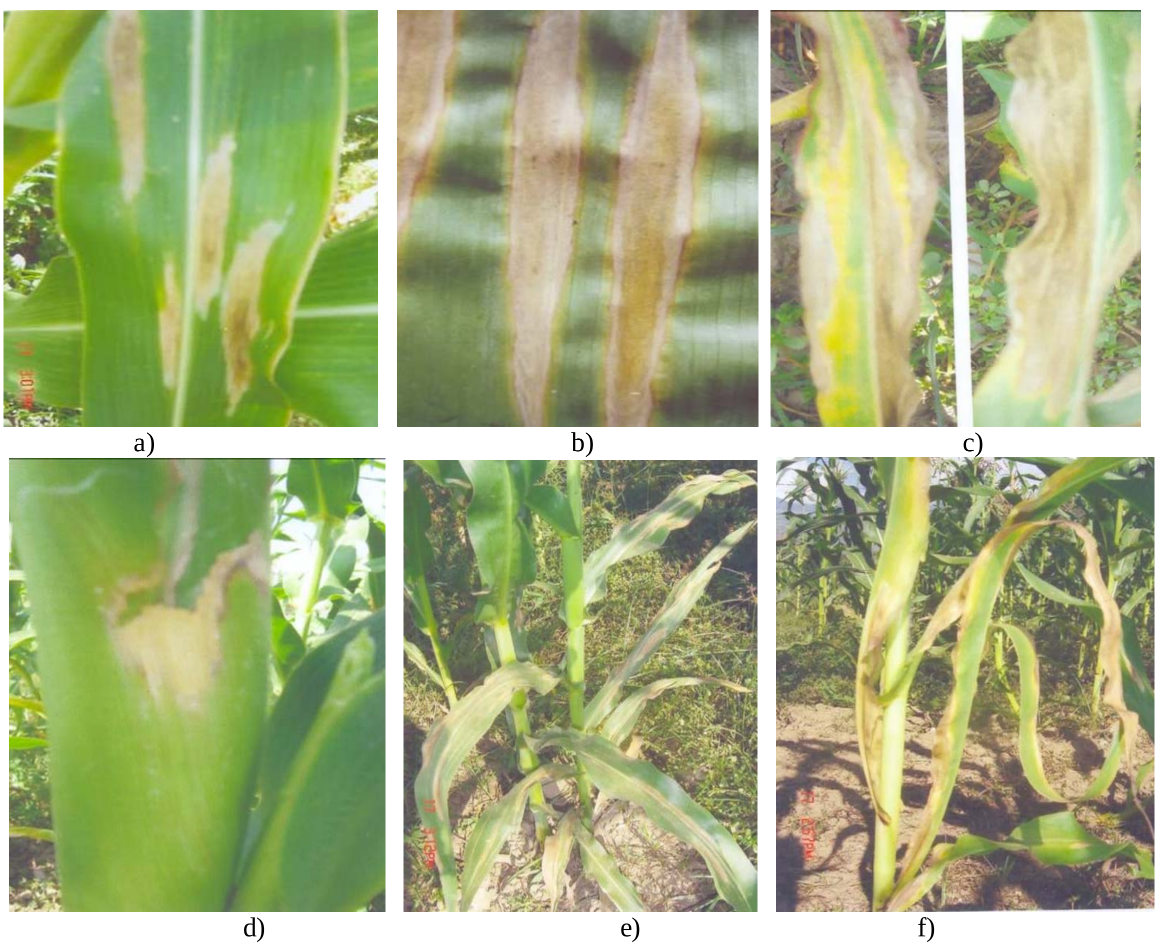

Figure 5. Turcicum leaf blight symptoms of two crosses [I-401(A) x I-318 (R) and I-15C(A) x I-318 (R)]. **a)** Elongated lesions on leaf; **b)** Mature lesions on leaf (centre covered by greyish black masses of conidia and condiophores); **c)** Leaf blight symptoms (coalescence of lesions); **d)** symptoms on cob sheath blight; **e)** Severe infection of *E. turcicum* on plant; f) plant showing leaf symptoms due to *E. turcicum.*

Table 2. Arc sine transformed mean disease incidence and severities of six generation of two crosses, I-15C(A) x I-318(R) and I-401(A) x I-318 (R) of maize for reaction to Turcicum leaf blight (*Exserohilum turcicum*).

Cross		Mean disease incidence (%)	Mean disease severity (%)	Reaction
Cross 15C(A) x I-318(R)				
P_1	I-15C(A)	61.06 (51.41)	18.13 (25.17)	MR
P_2	I-318(R)	33.29 (35.20)	14.00 (21.98)	MR
F_1	I-15C(A) x I-318(R)	57.36 (49.24)	16.26 (23.52)	MR
F_2	I-15C(A) x I-318(R)	59.32 (50.30)	20.08 (25.71)	MR
BC_1	[I-15C(A) x I-318(R)] I-15C(A)	60.15 (50.88)	20.50 (25.02)	MR
BC_2	[I-15C(A) x I-318(R)] I-318(R)	45.33 (42.31)	14.58 (21.54)	MR
Cross I-401(A) x I-318(R)				
P_1	I-401(A)	66.05 (57.33)	25.69 (28.27)	MS
P_2	I-318(R)	33.29 (35.20)	14.00 (21.98)	MR
F_1	I-401(A) x I-318(R)	67.60 (56.72)	19.96 (26.77)	MS
F_2	I-401(A) x I-318(R)	60.71 (49.24)	25.84 (27.84)	MS
BC_1	[I-401(A) x I-318(R)] x I-401(A)	65.10 (56.41)	27.91 (31.87)	MS
BC_2	[I-401(A) x I-318(R)] x I-318(R)	47.41 (42.30)	15.45 (22.54)	MR

MR = Moderately resistant (5.1-25.0% of leaf area infected); MS = moderately susceptible (25.1-50% of leaf area infected) (0-5 Scale of Maize Pathology Unit CIMMYT).

(MS) in cross I-401 (A) x I-318 (R) suggesting inheritance of resistance was governed by recessive genes. A single dominant gene in dent inbred GE 440 and in pop corn variety ladyfinger was detected by Hooker (1963) whereas mutagenic and major gene resistances for leaf blight have been reported by Jenkins and Roberts (1952) and Ullstrup (1970). Cross I-401 (A) x I-318 (R)F_1 was moderately susceptible (MS), suggesting that disease resistance was governed by additive genes in this cross. Thus, presence of resistant genes in both crosses can be exploited in the production of successful commercial hybrids by using these CMS sources as parents to develop TLB resistant, cost effective and stable hybrids. Also, further testing of these crosses through molecular markers can be helpful in identifying resistant gene in commercial hybrids.

Additive gene action was of major importance in all studies done on inheritance of corn leaf blight (Hughes and Hooker, 1975; Sigulas et al., 1988; Carson, 1998). Resistant lines had different set of genes controlling resistances operating at different levels of disease intensity across different generations as reported by Jenkins and Roberts (1952). Shankaralingam et al. (1989) also suggested that additive gene action and dominance x dominance type of epistasis with duplicate nature are important in controlling resistance to TLB. Thus, both dominance and additive gene effects seem to be governing resistance to leaf blight. Turcicum leaf blight, a ubiquitous foliar disease of maize for which diverse qualitative and quantitative sources are available need to be incorporated in the susceptible cultivars by back-crossing because of unstable nature of qualitative *Ht* genes as envisaged by Welz and Reiger (2000). Therefore, pedigree and recurrent selection methods should be used in development of high yielding and resistant cultivars.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES

Carson ML (1998). A new gene in maize conferring the ‘chlorotichole’ reaction to infection by *Exserohilumturcicum.* Plant Dis.79:717-720.

Chenulu VV, Hora TS(1962). Studies on losses due to *Helminthosporium* blight of maize. Indian Phytopathol.15:235-237.

Faostat (2010).Food and Agricultural Organization of the United Nations (FAO), FAO Statistical Database, from http://faostat.fao.org.

Frank T, Anna B, Albrecht EM (2013). Resistance in Maize with Combined or Separated Training Sets for Heterotic Groups. G3 Genes Genomes Genetics 3:197-203.

Hooker AL (1963). Inheritance of chlorotic-lesion resistance to *Helminthosporiumturcicum*in seedling corn. Phytopathology 55:189-192.

Hughes GR, Hooker AL (1975). Gene action conditioning resistance to northern corn leaf blight in maize. Crop Sci. 11:180-184.

Jenkins MT, Roberts AL (1952). Inheritance of resistance to *Helminthosporiumturcicum* leaf blight in populations of F_3 progenies. Agron. J. 44:438-442.

Karavina C, Mandum R, Mukaro R (2014). Evaluation of three way-maize (*Zea mays* L) hybrids for yield and resistance to *Maize streak virus* and Turcicum Leaf Blight diseases. J. Anim. Plant Sci. 24(1):216-220.

Koul TN (1957). Outbreak and new records.FOA Plant Prot. Bull. 5: 93-96.

Palaversic B, Jukic M, Jukic K, Zivkovic I, Buhinicek I, Jozinovic T,

Vragolovic A, Kozic Z, JemenarstvoS (2012). Breeding maize for resistance to Northern leaf blight (*Exserohilumturcicum* Pass.)[Croatian]. 29 (3/4):111-120.
Paliwal RL, Granodos G, Latiffe RH, Violic AD (2000). Tropical maize Improvement and Production*,* FAO: Rome.
Perkins JM, Pederson WL (1987). Disease development and yield losses associated with northern leaf blight on corn. Plant Dis. 71:940-943.
Shankaralingam S, Balasubramanian KA, Raghu Ram Reddy P (1989). Nature and type of gene action govering resistance to *Helminthosporium turcicum* leaf blight in maize (*Zea mays* L.). Genetica 79:121-127.
Sigulas KM, Hill RR, Ayers JE (1988). Genetic analysis of *Exserohilum turcicum* lesion expansion on corn. Phytopathology 78:149-153.
Steel RGD, Torrie JH (1980). *Principles and procedures of Statistics*. McGraw Hill, New York. 633 pp.
Tefera T, Mugo S, Beyene Y, Karayo H, Tende R (2011). Grain yield, Stem borer and disease resistance of new maize hybrids in Kenya. Afr. J. Biotechnol. 10 (23):4777-4783.
Ullstrup AJ (1970). History of southern corn leaf blight. Plant Dis. Rep. 54:1100-1102.
Welz HG, GeigerHH (2000). Genes for resistance to northern corn leaf blight in diverse maize populations. Plant Breed. 119:1-14.