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Evaluation of Lines and their Hybrids against Early Blight (*Alternaria solani*) in Tomato

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A B S T R A C T

Early blight (*Alternaria solani*) of tomato is one of the major biotic constraints in different ecologies the world. The highly loss in yield and quality of fruits leading to complete defoliation, are the most damaging in regions with heavy rainfall, high humidity and fairly high temperatures (24-29°C). The objective of this research was to compare between higher diseased incidence plant and lower diseased incidence plant based on yield as the measuring parameter in natural epiphytotic conditions. A line × tester analysis was conducted for evaluation of early blight disease of tomato in the Vegetable Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (India). Thirteen lines and thirty hybrids were screened in randomize block design with three replications following standard spacing under natural epiphytotic conditions against early blight of tomato in two *rabi* (winter) seasons. In first year, the maximum disease severity was recorded for the hybrid NDTVR-60 × KashiSharad (42.66%) with a minimum severity of 24.00% in Flora dade x BT 12 however, in second year maximum disease severity was also recorded for the cross NDTVR-60 × KashiSharad (44.00%) and minimum for Floradade × BT-12 (24.00%). In the first year, twenty-three hybrids were moderately resistant while six hybrids showed susceptible reaction and one of the hybrid (Flora dade × BT-12) showed resistant reaction for the early blight. In second year, twenty-two hybrids showed moderately resistance and seven hybrids were found susceptible. Data showed higher disease incidence was responsible for decreasing yield per plant in both the years and also identifying resistant cultivars for further research work.

***Key words*:** Early blight, Percent disease index, Resistant reaction, Susceptible, Tomato

Tomato is one of the most popular vegetables grown all over the world. India is the second largest tomato (*Solanumly copersicum* L.) producer in the world after China, accounting for about 11.5% of the world tomato production [1]. The area and production of tomato, in India is about 0.882 million hectare and 18.73 million tonnes, respectively [2]. Early blight (*Alternaria solani*) (Ellis & Martin) Sorauer of tomato is one of the major biotic constraints in different ecologies the world. The serious loss in yield and quality of fruits leading to complete defoliation, are the most damaging in regions with heavy rainfall, high humidity and fairly high temperatures (24-29°C). Epidemics can also occur in semi-arid climates where frequent and prolonged night dews occur [3]. Apart from the leaf symptoms known as early blight also causes collar rot (basal stem lesions at the seedling stage), stem lesions at adult plant stage and fruit rot [4]. Collar rot can inflict 20 to 40% seedling mortality [5]. Resistant cultivars are potentially the most economical control measure as they can extend the fungicide spray intervals while restricting the disease to an economic level [6]. Biotic stresses are the main problem in the agricultural field crops as well as horticultural crops. This problem can be resolved through development of resistant varieties against pathogens of the diseases. A number of diseases affect tomato production in India as well as all over the world. Early blight is the most destructive of these symptoms and hence receives considerable attention in breeding. Under field conditions, it leads to leaf and stem blight which causes defoliation of plant resulting in drastic reduction in fruit yield, while fruit infection in the field and after harvest results in rotting of tomato fruits in addition to affecting marketable quality. Therefore, current study on evaluation of tomato germplasm was undertaken with a view to identify the resistant tomato lines and hybrids.

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MATERIALS AND METHODS

Screening of germplasm

A study was conducted to screen 43 tomato genotypes comprising of 13 lines, 30 hybrids along with one check viz., Flora dade under natural epiphytotics of early blight at Vegetable Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (India) during rabi

seasons. The thirty crosses (F_1s) developed following line × tester mating design [7] involving ten lines and three testers (Table 2). Thirty days old seedlings were planted in Randomized Block Design with three replications following standard spacing and data were recorded for disease severity and yield performance. Disease severity was assessed by using 0-5 scale [8] and described as 0= less than one per cent leaf area infected, 1= 5-11 per cent leaf area infected, 2= 6-20 per cent leaf area infected, 3= 21-40 per cent leaf area infected, 4 = 41-70 per cent leaf area infected and 5 = more than 70 per cent leaf area infected. Ten plants were selected for recording disease severity and average yield calculated by summing up the weight of fruits obtained from all pickings and dividing it by number of plants. Disease reaction [Highly resistance (0-12.5), Resistance (12.6-25.0), Moderatly resistance (25.1-37.5), Susceptible (37.6-50) and highly susceptible (50.1 and above)] based on PDI was recorded following to the scale of [9] (Table 1).

Percent Disease Index (PDI) was calculated by using the following formula given by Wheeler [10].

$$PDI = \frac{\text{Sum of individual ratings}}{\text{No. of plants examined} \times \text{Highest grade of disease rating scale}} \times 100$$

Table 1 Description of genotypes involved in crossing program

Lines	Source	Special features
Fla-7171	University of Florida, USA.	Determinate, Fruits red, medium size with acid flavour, moderate heat tolerant and yield 1066.28 g/plant.
KashiAmrit	IIVR, Varanasi.	Determinate, Fruits spherical with 108 g. suitable for cultivation in TLCV infested period developed through back cross pedigree selection. This is a high yielding variety.
Selection-7	HAU, Hisar.	Determinate, early maturing, dwarf erect, with cut leave and synchronized clustered flowering bearing 15-20 fruits. Fruits are round, red, medium developed through modified pedigree method.
CO-3	TNAU, Coimbatore	Determinate, erect, compact, dwarf and bear 30-40 fruits. Fruits are round, globular, medium high vitamin 'C' and organic acid. Developed at and yield is 400-450 q/ha.
ATL-0239	IIVR, Varanasi.	Determinate, Fruits are red, round, medium.
NDTVR-60	NDUAT, Faizabad U.P.	Determinate, fruits are medium, round, red.
Punjab Upma	PAU, Ludhiana.	Determinate, Fruits are large, red, oval shape.
Floradade	Florida, USA.	Determinate, Vigorous, Fruits large, round, Resistant to early blight, and yield is 400-500 q/ha.
H-24	IIVR, Varanasi.	Determinate, Resistance to TLCV Developed through back cross-pedigree an inter-specific cross. Fruits are flatis-round, fleshy, medium, and red and yield 380-400q/ha.
DT-2	IARI, Delhi.	Determinate, Fruits large, round shape with high yield.
		Testers
KashiSharad	IIVR, Varanasi	Indeterminate, broad leaves, fruits attractive red oval, thick pericarp fruit wt. 90-95 g, and yield 400-500 q/ha.
BT-12	OUAT, Bhubaneshwar	Indeterminate, Plant height 70-85 cm, dense foliage, bearing 5-8 fruits per cluster, fruits are red pear shaped with green shoulder, 2-3 locules/fruit. Plants are resistant to bacterial wilt and early blight diseases and yield 450 q/ha.
ArkaAbha	IIHR, Bangalore	Semi-determinate, Fruits are medium round, red, bacterial wilt resistant and yield 350 q/ha.

RESULTS AND DISCUSSION

The early blight, caused by *Alternaria solani*, is a common fungal disease of tomato grow in fields, green house and high tunnels. In warm raining and wet weather epidemics of this disease can cause severe defoliation yield loss and poor fruit quality. The crop suffers from many fungal, viral, bacterial and nematode diseases which caused reduction in the yield and quality of produce. The fungus can infect most part of the tomato plant, including leaves, stems and fruits. Lesion on leaves first appear as small (less than 1/16 inch) brown spot surrounded by yellow decolouration. Diagnostic symptoms develop on the spots and became dark brown or black lesion with concentric ring, usually 1/3 to 1/4 inch diameter. Underfavarable conditions, many spots coalesce and result in severe defoliation. In recent years, the disease has assumed serious proportion in Karnataka. Therefore, it was thought desirable to investigate various aspects of the disease and pathogen viz., survey on severity and incidence of disease in the field, symptomatology, cultural and morphological characteristics of the pathogen effect of disease on yield parameters and etiology of the pathogen, chemical and biological control practices for the disease. The symptoms on tomato plants in the field were first noticed on the older leaves as minute brown to black necrotic spots measuring one to two mm in diameter. These spots often enlarged with concentric ring to produce characteristic target board effect. Later upward progress of the disease was observed and leaves dried up and drooped down. Similar description of symptoms on tomato and potato were made by Walker [11]. The disease appeared as brown to dark brown, elongated to oval cankerous spots on stems, petioles and calyx. On fruits, at stem end spots started as black or brown sunken lesions on fruits and stem and portion which later enlarged to considerable extent and they covered the whole fruits which ultimately led to their decay [12].

Disease severity in parents

Field survey during *rabi* PDI was significant for both the years (Table 2). Maximum disease severity was observed in the line KashiAmrit (54.33%) and minimum in BT-12 (24.00%) in first year, while maximum disease severity was observed in Fla7171 (55.00%) and minimum in BT-12 (24.66%) and Flora Dade (25.00%) in second year. The average incidence was (33.94%) in first year whereas in second year it was (33.66%). The PDI ranged from (24-54.33%) in first year, while in second year (24.66 to 55.00%) (Table 3).

Disease severity in hybrids

In first year, maximum disease severity was recorded in the crosses NDTVR × KashiSharad (42.66%) and minimum in Flora Dade × BT-12 (24.00%), while in second year maximum disease severity was also recorded for the Cross NDTVR-60 × KashiSharad (44.00%) with a minimum severity of 24.00% in Floradade × BT-12. The average incidence recorded in first year was (32.67%) and in second year was (33.13%). The PDI ranged were found in first year (24.00-42.66%) while in second year from (24.33 to 44.00%). Data were showed over the seasons, categorized as three type reactions viz; resistant, moderately resistant and susceptible for disease incidence. In the first year one cross (Flora Dade × BT-12) was found resistant, twenty-three crosses moderately resistant and six crosses showed susceptible reaction, while in second year also one cross (Floradade × BT-12) showed resistant reaction, twenty-two crosses showed moderately resistant and seven crosses were susceptible (Table 3).

Table 2 ANOVA for PDI against early blight in rabi

Source of variation	D.F.	PDI (First year)	PDI (Second year)
		Mean sum of squares	Mean sum of squares
Replication	2	7.18	19.78**
Treatment	43	125.03**	136.47**
Error	86	2.96	1.60

**Indicate significant at 1% level

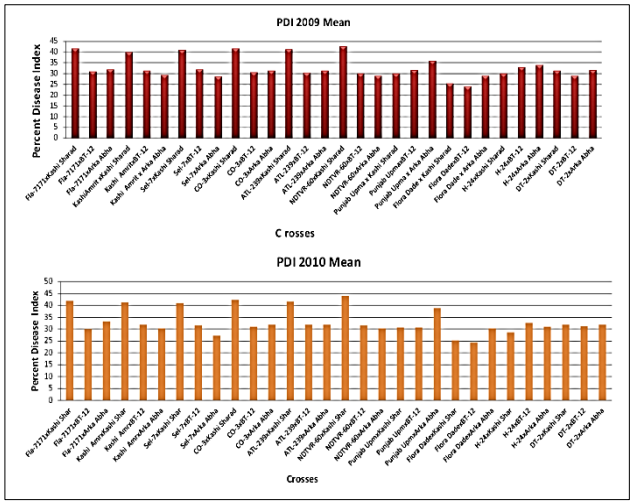

Fig 1 Percent disease index against early blight of tomato over two years (2009-2010)

All the parents, crosses along with checks showed higher disease incidence responsible for lower yield and lower disease incidence responsible for increasing yield per plant in both the years (Table 4). Yield losses up to 79% due to early blight damage were reported from Canada, India, USA, and Nigeria [13-15].

Such higher incidence of early blight was recorded by Datar and Mayee [16] with coefficient disease index of 11.66 per cent in Maharashtra. The results are also in conformity with the observations of Kanjilal *et al*. [17] in West Bengal. Prasad *et al*. [18] were observed that the maximum disease severity (52.55 PDI) was observed in Raichur district followed by Dharwad (47.87 PDI) and Gulbarga (39.39 PDI) districts. In different screening 15, 13 and 22 moderately resistant genotypes were obtained out of 40, 38 and 81 cultivars/lines by Begum [19], Banerjee *et al*. [20-22]. Eight lines (EC-520057, EC-520058, EC-520059, EC-520061, EC-508765, EC-538394, H-88-78-1 and EC-501583) showed highly resistant reaction against the fungus; three lines were found resistant, 5 lines moderately resistant whereas 33 lines showed moderately susceptible besides 57 susceptible and 36 highly susceptible lines against the disease under natural epiphytotic condition [23]. In the field experiment, among the twenty-four determinate variety and hybrids four varieties (Black Prince, Oregon spring, Zhezha and Bloody Butcher) showed resistant response with PDI 11-16, ten varieties and four hybrids were moderately resistant, four varieties were moderately susceptible and one variety (Napoli) and one hybrid (Lth-174) showed susceptible response with 68.88 PDI [24]. The early blight intensity and incidence varied from 21.66 to 34.13% and 10.48 to 18.56% in 15 genotypes under field conditions [25].

Survey

An investigation on the early blight of tomato caused by *A. solani* was carried out with reference to survey of the disease, etiology of the pathogen, variability studies of the pathogen, survivability, effect of disease on yield, against the disease under field conditions. It can be concluded that cross Flora Dade × BT-12 was resistant in both the years. The survey revealed that, the severity and incidence of early blight of tomato varied from season to season, most probably due to various factors like temperature, relative humidity, rainfall, sowing dates, diverse cultivars used and even it could also be attributed to existence of pathogenic variability.

Table 3 Severity of early blight on tomato lines and their crosses under natural epiphytotic

Genotypes	First year			Second year		
	PDI	DR	Yield Mean (Kg.)	PDI	DR	Yield Mean (Kg.)
Lines						
Fla-7171	54.33	S	1.26	55.00	S	1.27
KashiAmrit	53.00	S	1.67	54.66	S	1.71
Sel-7	30.66	MR	2.16	30.00	MR	2.59
CO-3	31.33	MR	2.25	32.66	MR	2.70
ATL-239	32.00	MR	1.97	32.33	MR	2.16
NDTVR-60	31.33	MR	2.68	31.66	MR	2.11
Punjab Upma	32.66	MR	2.44	35.00	MR	2.46
Floradade	25.33	MR	2.95	25.00	MR	2.62
H-24	34.00	MR	2.10	34.66	MR	1.71
DT-2	32.33	MR	1.88	34.00	MR	2.58

			Testers			
KashiSharad	29.00	MR	3.70	30.00	MR	3.32
BT-12	24.00	R	3.65	24.66	MR	3.13
ArkaAbha	31.33	MR	2.90	31.00	MR	2.39
			Check			
Floradade	26.00	MR	2.59	25.00	MR	2.62
			Crosses			
Fla-7171 × Kashi Sharad	41.67	S	1.79	42.00	S	1.01
Fla-7171 × BT-12	31.00	MR	2.81	30.00	MR	2.38
Fla-7171 × Arka Abha	32.00	MR	2.16	33.33	MR	2.11
KashiAmrit × KashiSharad	40.00	S	1.47	41.33	S	1.03
KashiAmrit × BT-12	31.33	MR	2.71	32.00	MR	2.68
KashiAmrit × ArkaAbha	29.33	MR	2.73	30.33	MR	2.67
Sel-7 × Kashi Sharad	41.00	S	1.55	41.00	S	1.20
Sel-7 × BT-12	32.00	MR	2.33	31.67	MR	2.68
Sel-7 × Arka Abha	28.67	MR	2.69	27.33	MR	2.65
CO-3 × Kashi Sharad	41.67	S	1.78	42.33	S	1.96
CO-3 × BT-12	30.67	MR	2.30	31.00	MR	2.48
CO-3 × ArkaAbha	31.33	MR	2.61	32.00	MR	2.19
ATL-239 × KashiSharad	41.33	S	1.63	41.67	S	1.02
ATL-239 × BT-12	30.33	MR	2.27	32.00	MR	2.67
ATL-239 × ArkaAbha	31.33	MR	1.97	32.00	MR	1.84
NDTVR-60 × KashiSharad	42.67	S	1.11	44.00	S	1.21
NDTVR-60 × BT-12	30.00	MR	2.17	31.67	MR	2.35
NDTVR-60 × ArkaAbha	29.00	MR	2.05	30.33	MR	1.99
Punjab Upma × KashiSharad	30.00	MR	2.20	30.67	MR	2.85
Punjab Upma × BT-12	31.67	MR	2.12	30.67	MR	2.31
Punjab Upma × ArkaAbha	36.00	MR	1.89	39.00	S	1.19
Floradade × KashiSharad	25.33	MR	2.65	25.33	MR	2.41
Floradade × BT-12	24.00	R	3.60	24.33	R	3.15
Floradade × ArkaAbha	29.00	MR	3.04	30.33	MR	2.05
H-24 × KashiSharad	30.00	MR	1.67	28.67	MR	2.70
H-24 × BT-12	33.00	MR	2.94	32.67	MR	2.78
H-24 × ArkaAbha	34.00	MR	2.06	31.00	MR	1.96
DT-2 × Kashi Sharad	31.33	MR	2.02	31.33	MR	2.78
DT-2 × BT-12	29.00	MR	2.92	31.33	MR	2.06
DT-2 × Arka Abha	31.67	MR	2.10	32.00	MR	1.86
CV	5.23	-	-	3.78	-	-
C.D.5%	2.79	-	-	2.05	-	-

DR: Disease reaction, R: Resistant, MR: Moderately Resistance, S: Susceptible

Table 4 Disease performance in thirty crosses against early blight of tomato

Disease reaction	First year		Second year	
	No. of crosses	Name of crosses	No. of crosses	Name of crosses
Resistance (12.60-25.00%)	1	Floradade × BT-12	1	Floradade × BT-12
Moderately Resistance (25.10-37.50%)	23	Fla-7171×BT-12, Fla-7171×Arka Abha, Kashi Amrit×BT-12, KashiAmrit × ArkaAbha, Sel-7×BT-12, Sel-7×Arka Abha, CO-3×BT-12, CO-3×Arka Abha, ATL-239×BT-12, ATL-239×Arka Abha, NDTVR-60×BT-12, NDTVR-60×Arka Abha, Punjab Upma × KashiSharad, Punjab Upma×BT-12, Punjab Upma × ArkaAbha, Flora Dade × KashiSharad, Flora Dade × ArkaAbha, H-24×Kashi Sharad, H-24×BT-12, H-24×Arka Abha, DT-2×Kashi Sharad, DT-2×BT-12, DT-2×Arka Abha	22	Fla-7171×BT-12, Fla-7171×Arka Abha, Kashi Amrit×BT-12, KashiAmrit × ArkaAbha, Sel-7×BT-12, Sel-7×Arka Abha, CO-3×BT-12, CO-3×Arka Abha, ATL-239×BT-12, ATL-239×Arka Abha, NDTVR-60×BT-12, NDTVR-60×Arka Abha, Punjab Upma × KashiSharad, Punjab Upma×BT-12, Flora Dade × KashiSharad, Flora Dade × ArkaAbha, H-24×Kashi Sharad, H-24×BT-12, H-24×Arka Abha, DT-2×Kashi Sharad, DT-2×BT-12, DT-2×Arka Abha
Susceptible (37.60-50.00%)	6	Fla-7171×Kashi Sharad, KashiAmrit × KashiSharad, Sel-7×Kashi Sharad, CO-3×Kashi Sharad, ATL-239×Kashi Sharad, NDTVR-60×Kashi Sharad	7	Fla-7171×Kashi Sharad, KashiAmrit × KashiSharad, Sel-7×Kashi Sharad, CO-3×Kashi Sharad, ATL-239×Kashi Sharad, NDTVR-60×Kashi Sharad, Punjab Upma × ArkaAbha

CONCLUSION

An investigation on the early blight of tomato caused by *Alternaria solani* was carried out with reference to survey of the disease, etiology of the pathogen, variability studies of the pathogen, survivability, effect of disease on yield, against the disease under field conditions. It can be concluded that cross (Flora Dade x BT-12) was resistant in both the years.

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