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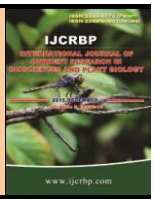

Original Research Article

A Black Sesame Variety Gujarat Til 10 (GT 10) Field Resistance to *Phytophthora* Blight Disease

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Abstract

Sesame is the oldest oilseed crop commonly known as til. *Phytophthora* blight in sesame is an economically important disease causing yield loss to a great extent when infection occurs severely at seedling stage. Screening of sesame entries for field resistance to *Phytophthora* blight under natural epiphytotic conditions was carried out in various Coordinated Varietal Trials and Regional Yield Trials during rainy seasons of 2013 and 2014. Out of several entries screened, released varieties Gujarat Til 10 (GT 10) found superior against *Phytophthora* blight disease in both the years. This was only the variety who recorded less than 10 per cent disease intensity ranging from 3.74 and 5.92% under high disease presser condition of 2013. In low disease presser condition of 2014, many entries appeared in resistance category but the least infection (1.51 to 2.67%) was observed in GT 10. In addition to *Phytophthora* blight resistance character, variety GT 10 showed statistically equal yield performance to other check varieties. On the basis of screening, resistant variety GT 10 should be recommended in areas where *Phytophthora* blight appears in severe form to sustain sesame productivity, but at the same time it should also be utilized in hybridization programmes to develop improved plant types.

Keywords

Field resistance
Phytophthora blight
Seed yield
Sesamum indicum
Varietal screening

Introduction

Sesame was a major oilseed crop in the ancient world because of its ease of extraction, great stability, and drought resistance. At present, it is cultivated in area of 9.4 million hectare with production of 3.48 million tonnes worldwide (FAO, 2013). Asia and Africa together contributes about 95% of the total production. India occupies an area of 18.60 lakh hectare accounting production of 6.36 Lakh tone with productivity of 342 kg/ha (FAO, 2013). The crop has its excellent cooking, medicinal, cosmetic and nutritional qualities. Sesame seed is a rich source of oil (50%) and protein (24%). Sesame oil primarily contributes olic, linolic, palmitic and steric fatty acids. Sesame productivity in India is very low in comparison to that of China and Egypt. One of the factors responsible to low productivity in India is disease and insect-pest attack.

A fungal disease caused by *Phytophthora parasitica* var. *Sesame*, known as *Phytophthora* blight, is an economically important disease affecting sesame plant growth and yield to great extent. It appears in all the area where sesame is grown. *Phytophthora* blight was first reported from India (Butler, 1918). In India, it is severe in M.P., Rajasthan, U.P., Gujarat, and moderate in Punjab, Haryana, Maharashtra, Andhra Pradesh, Tamilnadu, West Bengal and Bihar (Verma, 2002, Vasudeva, 1961). The yield loss due to this disease varied from 66.0 per cent in Gujarat to 79.8 per cent in Central Madhya Pradesh (Verma et al., 2005). The disease can occur at any stage of the plant; however, it is very serious at seedling stage and kills the affected plants. The mortality of the plants due to the disease may be as high as 72 to 80 percent (Reeti Singh et al., 2005). It may cause 100 per cent loss under most favourable conditions when infection occurs severely at seedling stage.

Initial symptom of *Phytophthora* blight is water soaked spots on leaves and stems. The spots are chestnut brown in the beginning, later turn to black. In humid weather, severity of disease increases, main root is affected, diseased plants are easily pulled out and produce shrivelled seeds and gives blighted appearance. High soil moisture favours the development of the pathogen. However, spraying of 0.3% Fytolan [copper oxychloride] at 20, 40 and 60 days after sowing are recommended for effective control of this disease and thereby yield loss (Kalita et al., 2002). Application of *Trichoderma viridae*, *T. harzianum* and *Pseudomonas fluorescence* as seed treatment reduces the disease significantly and increases the yield substantially (Verma, 2002).

Cultivation of resistant varieties is the most effective and cheap method to combat the disease as compared to chemical or biological control (Basavaraj et al., 2009). In India, resistance/ tolerance level in cultivated sesame germplasm is very low and whatever the resistant germplasm/wild species available in the country has not been effectively utilized in developing agronomically acceptable resistant varieties (Ranganatha et al., 2012). Mutant varieties resistance to *Phytophthora* in sesame has been developed in the Republic of Korea (Ashri, 2001) and Sri Lanka (Bedigian, 2010). Several workers screened sesame germplasm against powdery mildew disease (Sushama Nema and Duhoon, 2008; Padma Sundari and Kamala, 2012). However, such screening work on identification of resistance source against *Phytophthora* blight disease in sesame is meagrely reported. This paper describes field tolerance/ resistance performance of sesame genotypes against *Phytophthora* blight under natural condition of infection with special reference to cultivar Gujarat Til 10 (GT 10).

Materials and methods

Experimental site

Screening of sesame entries for field resistance to *Phytophthora* blight was conducted in various co-ordinated and state varietal testing programmes at the Agricultural Research Station, Junagadh Agricultural University, Amreli during 2013 and 2014 rainy seasons. The geographical position of the area lies between 21°35′79″N and 71°12′82″E with the elevation of 130 m above mean sea level. The soil of the experimental site was slightly alkaline medium black type and containing medium organic carbon with medium available N, low available P and high available K. Data on rainfall, temperature and relative humidity of 2013 and 2014 rainy season were collected from our meteorological observatory about 200 m away from the experimental site (Fig. 1).

Plant material and data collection

A total of 77 entries in 2013 and 64 entries in 2014 were screened in different trials. There were four checks repeatedly used in each trial for yield comparison. In Coordinated Varietal Trials the checks were: GT 10 (National check), TKG 22 (National check), Pragati (Zonal check) and GT 3 (Local check). All the entries including checks coded by Project Coordination Unit, Jabalpur were evaluated under Coordinated Varietal Trials and thereby presented the results of decoding entries. In Regional Yield Trials, the checks were: GT 2, GT 3, GT 4 and GT 10 with no coding of entries. Both Coordinated Varietal Trials and Regional Yield Trials were laid out in randomized complete block design (as details given in Table 1) at the rows length of 4.2 m in a plot. Seeds of each entry in the respective trial were sown by hand drilling keeping 60 cm distance between the rows. The crop was thinned at 15-20 days after germination making plant to plant distance of 10 cm. Leaf infections of *Phytophthora* blight disease was assessed on randomly selected five plants from each entry under natural epiphytotic conditions at 75 days after sowing using 0 to 5 rating scale (Rajpurohit, 1983). The disease reaction was categorized as highly resistant

(HR), resistant(R), moderately resistant (MR), moderately susceptible (MS), susceptible (S) and highly susceptible (HS) as per the disease severity range of 0%, 1 to10%, 11 to 25 %, 26 to 50 %, 51 to 70 % and 71 to 100%, respectively. The Percent Disease Intensity (PDI) was calculated according to Wheeler (1969).

$$PDI = \frac{\text{Sum of individual rating}}{\text{Total no of leaves examined (here in our case 10)}} \times \frac{100}{\text{Maximum grade in the rating scale (5)}}$$

Statistical analysis

Per cent disease intensity values of *Phytophthora* blight were subjected to arcsine transformation to restore the distribution to normality. It was not possible to determine yield level in 2013 due to sever attack of *Phytophthora* disease. Therefore, plot basis yield data were obtained in 2014 only. The 1000-seed weight (g) of check varieties was measured from the produce of 2014 season. Replicated data for disease infection and seed yield were subjected to statistical analysis according to the design on SAS software (SAS Institute, 2004).

Results

Weather conditions

The rainfall data as well as mean values of minimum and maximum temperature and relative humidity recorded during crop duration in 2013 and 2014 are presented in Fig. 1. Rainfall total recorded during the season was markedly lower in 2014 (655.3mm) than 2013 (761.3mm) with total rainy days of 31 and 40, respectively. However, amount for both years were within recommended range of 600– 800 mm of rainfall. Per cent total rainfall distribution and minimum relative humidity in the month of June and October was higher in 2013 than 2014 (Fig. 1). Temperatures during June and July of 2013 were about 4 degree low than those of 2014. Thus, higher rainfall and higher relative humidity with relatively low temperature at early season of 2013 might have provided favourable environment for *Phytophthora* disease development to occur during seedling stage (Fig.2).

Fig. 1: Month wise weather parameters during crop period for the year 2013 (A) and 2014(B).

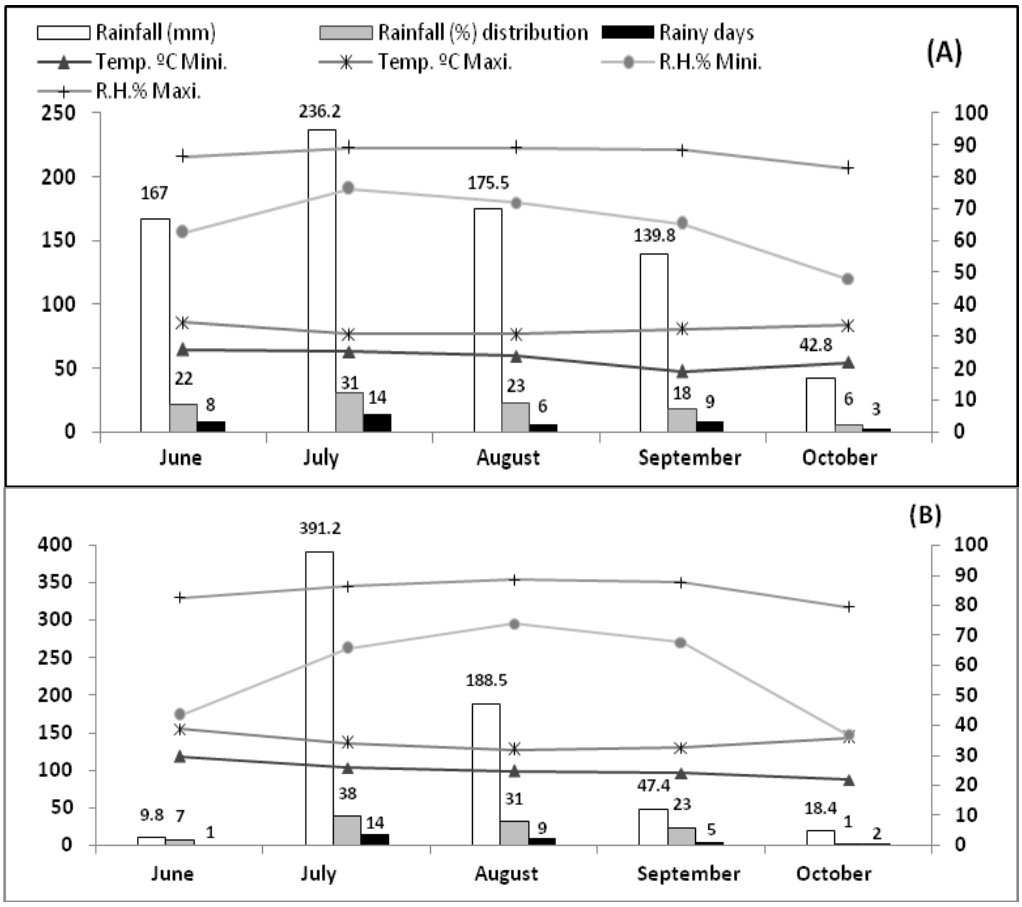

Table 1. Details of the trials conducted in 2013 and 2014 rainy season.

Year	Trial[@]	Replications	Entries screened	Plot size (m)	Rows/plot
2013	IVT [+]	3	17	4.2 × 3.0	5
	AVT [+]	4	10	4.2 × 3.6	6
	LSVT [£]	4	8	4.2 × 3.6	6
	SSVT [£]	4	14	4.2 × 3.0	5
	PET [£]	2	28	4.2 × 1.2	2
2014	IAVT [+]	4	14	4.2 × 3.6	6
	LSVT [£]	4	8	4.2 × 3.6	6
	SSVT [£]	4	14	4.2 × 3.0	5
	PET [£]	2	28	4.2 × 1.2	2

[@] IVT=Initial varietal trial, AVT= Advanced varietal trial, IAVT= Initial advanced varietal trial, LSVT= Large scale varietal trial, SSVT= Small scale varietal trial, PET= Preliminary evaluation trial, [+] Coordinated Varietal Trials, [£] Regional Yield Trials

Fig. 2: *Phytophthora* infected sesame plant (seedling stage).

Phytophthora blight incidence

Phytophthora blight was appeared at early seedling stage of the crop in 2013 and subsequently the incidence became severe at late capsule formation stage. In 2014, the incidence of this disease was started at late flowering stage and found to be low. The 2013 season might have provided favourable environmental conditions (continuous rainfall, high humidity and relatively low temperature) particularly during sowing and seedling establishment stage (Fig. 1). Average score of 5 plants in each variety was taken to determine the disease reaction. *Phytophthora* infection revealed significant differences among the entries in all the trials conducted during 2013 and 2014 rainy season (Table 2).

Table 2. Mean and range of per cent disease index (PDI) of *Phytophthora* blight and best entry against this disease in different trials -2013 and 2014.

A	Entries + Checks	Mean	Range	Entry showing <10 PDI (no.)	Best entry with PDI score
Kharif-2013					
IVT [+]	13+4	74.35	5.29 – 91.70*	1	G.Til 10 (5.29)
AVT [+]	6+4	65.27	5.92 – 86.20*	1	G.Til 10 (5. 92)
LSVT [£]	4+4	71.23	5.92 – 89.58*	1	G.Til 10 (5. 92)
SSVT [£]	10+4	63.78	5.92 – 89.23*	1	G.Til 10 (5. 92)
PET [£]	24 + 4	19.22	3.74 – 39.00*	1	G.Til 10 (3.74)
Kharif-2014					
IAVT [+]	10+4	8.56	2.25 –21.46*	8	G.Til 10 (2. 25)
LSVT [£]	4+4	5.21	2.67 – 7.99*	All	G.Til 10 (2. 67)
SSVT [£]	10+4	17.08	1.51 – 38.44*	2	G.Til 10 (1. 51)
PET [£]	24+4	19.48	1.61 – 45.00*	3	G.Til 10 (1. 61)

[@] IVT=Initial varietal trial, AVT= Advanced varietal trial, IAVT= Initial advanced varietal trial, LSVT= Large scale varietal trial, SSVT= Small scale varietal trial, PET= Preliminary evaluation trial, [+]Coordinated Varietal Trials, [£] Regional Yield Trials.
*Significance marked on the basis of F-test at $p< 0.05$.

In 2013, the highest disease infection of 91.70% was observed in the Initial Varietal Trial (IVT) and the lowest of 3.74% was recorded in the Preliminary Evaluation Trial (PET). On an average, *Phytophthora* blight incidence during this year ranged from19.22 % (PET) to 74.35% (IVT). In general, the experimental mean values of disease incidence were closer to the more susceptible reaction, the exception being experimental mean value of PET. Among the entries tested in 2013 season, only one entry in each trial showed less than 10% infection of *Phytophthora* blight and that was the check variety GT 10.

In 2014, the incidence was the highest (45.00%) in the PET and the lowest (1.51%) in the Small Scale Varietal Trial (SSVT). On an average, the range of *Phytophthora* leaf infection was observed from 5.21 % in Large Scale Varietal Trial (LSVT) to 19.48% in PET. The *Phytophthora* blight infection less than 10 % was observed in eight out of 14 entries of IAVT, eight out of eight entries of LSVT, two out of 14 entries of SSVT and three out of 28 entries of PET. In general, the entries in all the trials tended to show disease reaction more toward resistance. However, the best entry with the lowest PDI score was check variety GT 10.

Field screening under natural epiphytotic conditions during 2013 and 2014 rainy seasons indicated that none of the entries tested in various trials had any incidence of *Phytophthora* (0% incidence) on plants at 75 days after sowing (Table 3). However, one entry in each trial of 2013 showed resistant reaction to *Phytophthora* under field conditions. Majority of the IVT, AVT, LSVT and SSVT entries in 2013 expressed the reaction toward highly susceptible or susceptible. But most of the PET entries categorized as moderately resistance and none as susceptible or highly susceptible. During 2014, entries in various trials tended to show resistance or moderately resistance reaction and none were found under susceptible or highly susceptible category.

Table 3. Number of entries falling in different categories of disease reaction (2013 and 2014).

Trials[@]	Disease reaction category					
	HR (0 %)	R (1-10 %)	MR (11-25 %)	MS (26-50 %)	S (51-70 %)	HS (71-100 %)
Kharif-2013						
IVT [+]	0	1	1	0	3	12
AVT [+]	0	1	0	1	2	6
LSVT [£]	0	1	0	0	0	7
SSVT [£]	0	1	0	1	7	5
PET [£]	0	1	22	5	0	0
Kharif-2014						
IAVT [+]	0	8	6	0	0	0
LSVT [£]	0	8	0	0	0	0
SSVT [£]	0	2	8	4	0	0
PET [£]	0	3	18	7	0	0

[@] IVT=Initial varietal trial, AVT= Advanced varietal trial, IAVT= Initial advanced varietal trial, LSVT= Large scale varietal trial, SSVT= Small scale varietal trial, PET= Preliminary evaluation trial, [+]Coordinated Varietal Trials, [£] Regional Yield Trials.
HR= highly resistant, R = resistant, MR = moderately resistant, MS = moderately susceptible, S=susceptible and HS= highly susceptible.

Seed yield

Early growth of sesame in 2013 was severely impaired due to endemic of *Phytophthora* blight and it was not possible to determine yield level. Yield data of 2014 experiments are summarized in Table 4. Seed yield differences were found significant among the entries tested in all the experiments. None of the entries gave significantly higher yield over general mean (GM) in IAVT trial. However, one entry in LSVT, two entries in SSVT and two entries in PET significantly out yielded over GM. Yield comparison of check varieties indicated non-significant differences among themselves. However, GT 4 recoded numerically higher seed yield than other check varieties in the trial in which it appeared. With respect to seed size, GT 3 revealed the highest 1000-seed weight in all the trials. Statistically non-significant seed yield differences among the check varieties in respective trial imply that all the checks will perform in the same way and any of them could be suggested to grow commercially.

Table 4. Mean and range for seed yield (kg/ha) and 1000-seed weight (g), comparison of GT 10 with other check varieties in different trials-2014.

Parameters	Name of trials[@]			
	IAVT[+]	LSVT[£]	SSVT[£]	PET[£]
Trial yield (kg/ha)				
Mean	1131	1505	1271	1554
Min.	535	1340	932	1111
Max.	1343	1775	1698	2815
Check variety yield(kg/ha)				
G.Til 10	1201(2.70)	1340(2.66)	1209(2.66)	1671(2.62)
TKG 22	1215(2.76)	-	-	-
Pragati	1337(2.80)	-	-	-
G.Til 2	-	1393(2.66)	1286(2.76)	1551(2.72)
G.Til 3	1267(2.86)	1353(2.96)	1294(3.00)	1639(2.84)
G.Til 4	-	1461(2.62)	1453(2.68)	1836(2.78)
S.Em.±	83.47	89.19	100.89	169.97
CD at 5 %	239	262	289	493
CV%	14.77	11.85	15.87	15.47

[@] IVT=Initial varietal trial, AVT= Advanced varietal trial, IAVT= Initial advanced varietal trial, LSVT= Large scale varietal trial, SSVT= Small scale varietal trial, PET= Preliminary evaluation trial, [+] Coordinated Varietal Trials, [£] Regional Yield Trials.
- Check variety not included in trial, Figure in parenthesis indicates weight of 1000 seeds in gram

Discussion

Where a disease is one of the important limiting factors for crop cultivation, the evaluation of the reaction of sesame germplasm to infection is an important goal for plant breeding programs. Therefore, the use of resistant varieties becomes part of integrated disease management, and is the ideal way for preventing damage to crops by diseases. *Phytophthora* blight, caused by *Phytophthora parasitica* var. *sesami*, is a serious disease in India that limits production of sesame. The use of resistant genotypes is a long-term solution to control this malady (Ranganatha et al., 2012). Present investigation was carried out in two years. In both the years, experiments were sown on same date on 14th July. Various sesame entries under different trials were screened under natural condition of *Phytophthora* infection. In 2013 season, *Phytophthora* blight infection was started in early seedling stage while in 2014 season it was started at late flowering stage. *Phytophthora* infection was observed up to 91.7% in 2013 and 45.0% in 2014 (Table 2).This suggests that occurrence of the disease was more severs in 2013 than 2014. Persistence of continuous rain and humid weather for a longer time during sowing to seedling establishment stage in 2013 (Fig. 1) might have favoured the infection of disease quite fast. Verma et al. (2005) also found similar situation for *Phytophthora* disease development in sesame. Further, they opined that high humidity for long period and 25-35^{0}C temperature is necessary for disease development but pathogen failed to grow above 35^{0}C temperature. Early seedling stage infection of *Phytophthora* blight in 2013 affected the growth and development of sesame crop to a great extent. Only one entry i.e., G.Til 10 scored below10% PDI ranging between 3.74 and 5.92%.

In 2014, trend of disease reaction was somewhat different as observed in 2013 (Table 3). In each trial, more number of entries tended to show disease reaction toward resistance direction. Such rating toward resistance direction may be attributed to low disease pressure during crop period in this year. Check variety G. Til 10 in all the trials of 2014 also expressed the least *Phytophthora* infection (1.51 to 2.67% PDI). Similar field screening study in sesame for powdery mildew disease has been reported by Sushama Nema and Duhoon (2008) and Padma Sundari and Kamala (2012). Pathirana (1992) screened the induced mutant population of sesame against *Phytophthora* disease under natural epiphytotic condition and developed *Phytophthora* tolerant sesame variety (Pathirana et al., 2000).

Chemical control of sesame diseases is difficult and seldom economic. Improved agricultural practices accompanied by research on increasing disease resistance is a major concern in sesame breeding (Weiss,

2000), specially because in developing countries other means of control are scarcely used. Very few efforts have been made to identify disease resistance sesame germplasms. This may be due to the lack of easy methods for disease screening (Ranganatha et al., 2012) and also the nonavailability of resistant material in germplasm collections for cross breeding (Verma et al., 2005). Besides this, sesame cultivars considered resistant in a particular country, frequently proved highly susceptible elsewhere (Weiss, 2000). This may be the reason why we could not find material resistant to *Phytophthora* disease in the germplasm screening experiments. A well designed programme for developing disease resistant sesame cultivars has been continuing in Korea for several years. Selection for resistance to *Phytophthora* blight was possible when 20-day old seedlings were infected by inoculating the soil with 200 sporangia/ml and the pots were half- immersed in water.

Induction of mutation in early Russian variety has led to the development and release of the disease resistant mutant Ahnsakkae (Kang and Van Zanten, 1996). This variety and other mutants have later served as initial material for development of *Phytophthora* resistant cultivars 'Suwonkkae' in Korea (Pathirana et al., 2000) and cultivar 'ANK S2' in Sri Lanka (Bedigion, 2010). In Korea, a black sesame variety 'Kangheuk' is developed by hybridization followed by pedigree selection with *Phytophthora* blight resistance and high yielding (Shim et al., 2012).

The variety GT 10 described in this paper was released for commercial cultivation by Agricultural Research Station Junagadh Agricultural University Amreli, India in 2002. It was developed by selection from TNAU 17 variety. It is the variety with black coloured seeds with profuse branches, medium stature (120 cm) and maturing in about 92-95 days (Table 5). It is resistant to *Phytophthora* blight (Table 2) and its yielding ability is statistically on par with the other recommended check varieties (Table 4). The highest yield potential recorded is 1671 kg h^{-1} at Amreli location under rainfed conditions. This variety is suitable for the Western region of India where the occurrence of *Phytophthora* blight is prevailing. Nevertheless, high yield potential exhibited in other areas of the dry zone has made it a valuable cultivar for the country as national check in different breeding programmes (AICRP, 2013). This variety is also identified as resistance source of powdery mildew disease (Sushama Nema and Duhoon, 2008). Thus, GT 10 variety of sesame indicates multiple disease resistance and requires further investigations. The disease resistance characteristic of GT 10 should be exploited to expand the sesame area in the country as well as in cross breeding to develop new cultivars with improved traits.

Table 5. Characteristics of sesame variety GT 10.

1	Name of variety	: G.Til 10
2	Pedigree	: Selection from TNAU 17
3	Days to 50% flowering	: 46
4	Flower petal colour	: Pinkish white
5	Flower petal hairiness	: Sparse
6	Plant height (Main stem)	: 120 cm
7	Branching	: Branched
8	Number of Branches/plant	: 5-6
9	Stem hairiness	: Absent
10	Leaf colour	: Pale green
11	Number of capsules/ plant	: 89
12	Capsule hairiness	: Absent
13	Number of locules /capsule	: Four
14	Capsule shape	: Tapered
15	Capsule number/leaf axil	: One
16	Capsule arrangement	: Alternate
17	Days to maturity	: 92-95
18	Seed coat colour	: Black
19	1000 seed weight	: 3.04 g
20	Oil content	: 45.2%
21	Reaction to diseases	: Tolerant to *Phytophthora* blight
22	Potential yield	: 1671 kg/ha

Conclusion

The use of resistant varieties has been strongly advocated for the integrated disease management in crop like sesame, especially for *Phytophthora* blight as it is important soil born disease occurring at any stage of the crop. The results of present study indicated that sesame variety GT 10 seems to be resistant to *Phytophthora* blight disease as per cent disease intensity was less than 10% with the least disease score over all other entries in both the years. It gave seed yield statistically on par with the yield of other check varieties. Thus, the GT 10 high yielding variety of sesame identified for *Phytophthora* blight resistant through this investigation can be deployed in disease endemic areas to aim for sustainable productivity or it can be used as a parent material in future breeding programmes.

Acknowledgement

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SUPPLEMENTARY DATA

Table A. Month wise Rainfall, Temperature and Relative humidity during crop growth period (year 2013 and 2014).

Month	2013							2014						
	Rainfall (mm)	Per cent distribution	Rainy days	Temperature °C		Relative Humidity %		Rainfall (mm)	Per cent distribution	Rainy days	Temperature °C		Relative Humidity %	
				Mini.	Maxi.	Mini.	Maxi.				Mini.	Maxi.	Mini.	Maxi.
June	167.0	22	08	25.9	34.4	62.5	86.3	9.8	7	1	29.6	38.6	43.3	82.5
July	236.2	31	14	25.2	30.8	76.3	89.0	391.2	38	14	25.8	34.0	65.5	86.3
August	175.5	23	06	23.9	30.8	72.0	89.0	188.5	31	9	24.6	31.7	73.8	88.4
September	139.8	18	09	19.1	32.4	65.3	88.3	47.4	23	5	24.0	32.5	67.5	87.5
October	42.8	6	03	21.9	33.5	48.0	82.6	18.4	1	2	21.9	35.7	36.8	79.4
Total	761.3	100	40					655.3	100	31				

Table B. Incidence of *Phytophthora* blight under Coordinated Varietal Trials -2013

S/N	IVT		AVT	
	Name of entry	Phy. Bl.	Name of entry	Phy. Bl.
1	JLS-408-2	56.51(69.55)	MT-10-23-3	58.82(73.20)
2	AT-282	69.77(88.05)	GT-10(NC)	14.08(05.92)
3	TKG-22(NC)	67.68(85.57)	Pragati (ZC)	67.36(85.18)
4	RT-367	71.62(90.06)	JLS-9707-2	66.63(84.26)
5	VS-07-023	28.37(22.57)	TKG-22(NC)	62.97(79.35)
6	JLS-302-11	48.84(56.68)	OSC-79	46.73(53.01)
7	RT-366	64.53(81.51)	MT-10-8-1	59.38(74.06)
8	AT-249	67.68(85.57)	OSC-207	40.67(42.47)
9	JLS-120	50.77(60.00)	OSC-560	54.08(65.58)
10	RT-368	57.82(71.64)	G.Til-2 (LC)	68.19(86.20)
11	MT-11-8-2	72.37(90.83)	-	-
12	GT-10(NC)	13.30(05.29)	-	-
13	Pragati (ZC)	65.27(82.50)	-	-
14	LT-210	69.77(88.05)	-	-
15	PT-2	73.25(91.70)	-	-
16	PT-10	64.04(80.84)	-	-
17	G.Til-2 (LC)	71.05(89.46)	-	-
	Mean	59.57(74.35)	Mean	53.89(65.27)
	S. Em±	2.03	S. Em±	1.79
	C.D. at 5 %	5.86	C.D. at 5 %	5.20
	C.V. %	5.92	C.V. %	6.65

IVT=Initial varietal trial, AVT= Advanced varietal trial, NC=National Check, ZC =Zonal Check, LC= Local Check; Data in parentheses are re-transformed arcsine values.

Table C. Incidence of *Phytophthora* blight under Regional Yield Trials -2013.

S/N	LSVT		SSVT		PET	
	Name of entry	Phy. Bl.	Name of entry	Phy. Bl.	Name of entry	Phy. Bl.
1	AT-249	60.39(75.59)	AT-306	55.29(67.58)	AT-325	21.9(13.94)
2	AT-253	60.08(75.11)	AT-307	56.54(69.61)	AT-326	21.0(12.85)
3	AT-265	63.34(79.86)	AT-308	52.28(62.56)	AT-327	25.8(18.99)
4	AT-282	68.19(86.20)	AT-311	50.78(60.02)	AT-328	25.5(18.48)
5	G.Til-2(LC)	71.16(89.58)	AT-314	52.56(63.04)	AT-329	27.3(20.99)
6	G.Til-3(LC)	59.11(73.64)	AT-315	49.92(58.55)	AT-330	22.8(14.99)
7	G.Til-4(LC)	64.14(80.97)	AT-316	48.17(55.53)	AT-331	25.0(17.82)
8	G.Til-10(LC)	14.08(5.92)	AT-319	57.76(71.55)	AT-332	25.5(18.48)
9	-	-	AT-323	58.51(72.72)	AT-333	19.2(10.82)
10	-	-	AT-324	40.97(42.98)	AT-334	24.1(16.70)
11	-	-	G.Til-2(LC)	63.40(79.96)	AT-335	21.9(13.94)
12	-	-	G.Til-3(LC)	70.72(89.10)	AT-336	23.2(15.52)
13	-	-	G.Til-4(LC)	70.84(89.23)	AT-337	30.0(24.99)
14	-	-	G.Til-10(LC)	14.08(5.92)	AT-338	33.2(29.98)
15	-	-	-	-	AT-339	35.1(33.00)
16	-	-	-	-	AT-340	28.6(22.93)
17	-	-	-	-	AT-341	21.9(13.94)
18	-	-	-	-	AT-342	21.9(13.94)
19	-	-	-	-	AT-343	27.2(20.92)
20	-	-	-	-	AT-344	21.0(12.85)
21	-	-	-	-	AT-345	25.8(18.99)
22	-	-	-	-	AT-346	27.3(20.99)
23	-	-	-	-	AT-347	25.1(17.96)
24	-	-	-	-	AT-348	27.2(20.92)
25	-	-	-	-	G.Til-2(LC)	33.2(29.98)
26	-	-	-	-	G.Til-3(LC)	36.3(34.97)
27	-	-	-	-	G.Til-4(LC)	38.6(39.00)
28	-	-	-	-	G.Til-10(LC)	11.2(3.74)
	Mean	57.56 (71.23)	Mean	53.0(63.78)	Mean	26.0(19.22)
	S. Em±	2.09	S. Em±	1.76	S. Em±	2.38
	C.D. at 5 %	6.14	C.D. at 5 %	5.05	C.D. at 5 %	6.92
	C.V. %	7.25	C.V. %	6.66	C.V. %	12.99

LSVT= Large scale varietal trial, SSVT= Small scale varietal trial, PET= Preliminary evaluation trial, NC=National Check, ZC=Zonal Check, LC= Local Check; Data in parentheses are re-transformed arcsine values.

Table D. Incidence of *Phytophthora* blight under Coordinated Varietal Trials and Regional Yield Trials -2014.

S/N	IAVT+		LSVT£		SSVT£		PET£	
	Name of entry	Phy. Bl.	Name of entry	Phy. Bl.	Name of entry	Phy. Bl.	Name of entry	Phy. Bl.
1	MT-11-1-13	26.80(20.32)	AT 249	1.72 (2.94)	AT 306	20.97 (12.81)	AT 325	30.99(26.51)
2	RT-369	27.60(21.46)	AT 253	2.83(7.99)	AT 307	20.66(12.45)	AT 326	29.26(23.88)
3	JLS-606-7-2	19.29(10.91)	AT 265	1.96(3.83)	AT 308	38.31(38.44)	AT 327	26.96(20.55)
4	GT-10(NC)	8.62(02.25)	AT 282	2.54(6.43)	AT 311	30.43(25.66)	AT 328	33.16(29.92)
5	DS-7	10.67(03.43)	G.Til 2 (C)	2.34(5.45)	AT 314	29.56 (24.34)	AT 329	37.33(36.77)
6	RT-370	20.58(12.36)	G.Til 3 (C)	2.34(5.45)	AT 315	37.32(36.76)	AT 330	28.39(22.61)
7	TKG-22(NC)	18.65(10.23)	G.Til 4 (C)	2.63(6.90)	AT 316	25.74(18.87)	AT 331	33.70(30.78)
8	DS-26	10.67(03.43)	G.Til 10(C)	1.63(2.67)	AT 319	21.46(13.39)	AT 332	24.34(16.99)
9	TKG-501	9.88(02.95)	-		AT 323	30.26(25.40)	AT 333	24.97(17.82)
10	RT-371	21.49(13.42)	-	-	AT 324	21.06(12.92)	AT 334	21.01(12.85)
11	Pragti(ZC)	9.10(02.50)	-	-	G.Til 2 (LC)	21.44(13.37)	AT 335	29.01(23.52)
12	LT-210	17.20(08.75)	-	-	G.Til 3 (LC)	12.16(4.44)	AT 336	26.46(19.85)
13	DS-34	12.01(04.33)	-	-	G.Til 4 (LC)	25.36(18.35)	AT 337	21.01(12.85)
14	G Til - 3(LC)	10.67(03.43)	-	-	G.Til 10 (LC)	07.06(1.51)	AT 338	19.35(20.98)
15	-	-	-	-	-	-	AT 339	25.83(18.99)
16	-	-	-	-	-	-	AT 340	25.78(18.91)
17	-	-	-	-	-	-	AT 341	26.32(19.65)
18	-	-	-	-	-	-	AT 342	23.58(16.00)
19	-	-	-	-	-	-	AT 343	27.95(21.97)
20	-	-	-	-	-	-	AT 344	42.13(45.00)
21	-	-	-	-	-	-	AT 345	18.35(09.91)
22	-	-	-	-	-	-	AT 346	21.01(12.85)
23	-	-	-	-	-	-	AT 347	18.35(09.91)
24	-	-	-	-	-	-	AT 348	34.94(32.81)
25	-	-	-	-	-	-	G.Til 2 (LC)	20.20(11.93)
26	-	-	-	-	-	-	G.Til 3 (LC)	24.34(16.99)
27	-	-	-	-	-	-	G.Til 4 (LC)	31.30(26.99)
28	-	-	-	-	-	-	G.Til 10(LC)	07.29(01.61)
	Mean	15.95(8.56)	Mean	2.25(5.21)	Mean	24.41(17.08)	Mean	26.19(19.48)
	S. Em±	1.41	S. Em±	0.20	S. Em±	2.45	S. Em±	3.35
	C.D. at 5 %	4.04	C.D. at 5 %	0.59	C.D. at 5 %	7.01	C.D. at 5 %	9.71
	C.V. %	17.73	C.V. %	17.79	C.V. %	20.06	C.V. %	18.01

IAVT= Initial advanced varietal trial, LSVT= Large scale varietal trial, SSVT= Small scale varietal trial, PET= Preliminary evaluation trial' + Coordinated Varietal Trials, £ Regional Yield Trials, NC=National Check, ZC =Zonal Check, LC= Local Check; Data in parentheses are re-transformed arcsine values.