Received: 08 May 2020 | Revised: 14 Nov 2020 | Accepted: 17 Nov 2020

Electronic Journal of Plant Breeding

Research Note

Screening of sesame (*Sesamum indicum* L.) genotypes for major diseases

Manjeet[1]*, Ram Avtar[1], Anil Kumar[2], R K Sheoran[1] and P K Verma[1]

[1]Department of Genetics and Plant Breeding,
[2]Department of Plant Pathology,CCS Haryana Agricultural University, Hisar, Haryana (India)-125 004
*E-Mail: manjeetsingh125033@gmail.com

Abstracts
Sesame (*Sesamum indicum* L.) is a diploid species belonging to Pedaliaceae family and an ancient *kharif* oilseed crop of India which is grown mainly for its edible oil. The production and productivity of sesame is constrained by various biotic and abiotic stresses. In the present investigation, 24 sesame (*Sesamum indicum* L.) genotypes were screened under natural field conditions against major diseases *viz*. phyllody, charcoal rot and leaf curl. Among the 24 sesame genotypes, only four genotypes namely JLS 110-12, HT 9913, T 78 and KMR 60 were found to possess multiple disease resistance with 0-8.8 % disease incidence against aforementioned diseases while three genotypes namely HT 9913, T 78 and KMR 60 registered 0 % incidence of leaf curl disease. These resistant sources might be very useful as donor parents in hybridization programme for the development of multiple disease resistant and high yielding varieties in future sesame crop improvement programme.

Keywords
Sesame, Genotype, Disease resistance, Disease incidence

Oilseed crops play a key role in agriculturally based economy of India (Singh *et al*., 2020). Among nine major oilseed crops grown in India, sesame (*Sesamum indicum* L.) is an important and ancient crop belongs to family Pedaliaceae, and is commonly known as "Queen of Oilseeds" (Sandhiya *et al*., 2020). India is one of the largest exporters of sesame seeds exporting approximately 3 to 4 million tons of seeds annually. About 70% of the world's sesame seed is processed into meal and oil. Total annual consumption of sesame seeds is about 65% for oil extraction and 35 % for direct consumption as food. The meal left after oil extraction process contains approximately 35-50 % proteins and is used as a protein rich feed for poultry and livestock (Biswas *et al*., 2018). Sesamin and sesamolin are two unique phytoconstituents isolated from seeds and possess an excellent cholesterol-lowering effect which prevents high blood pressure in humans (Şahin and Elhussein, 2018). Despite the economic importance for food, oil, and medicine (Pathak *et al*., 2014), the yield potential of sesame crop is very low as compared to other major oilseed crops *viz*., soybean, groundnut, rapeseed-mustard and sunflower due to its cultivation in sub-marginal lands and non-availability of superior high yielding varieties lacking inbuilt resistance to biotic stresses (Manjeet *et al*., 2020). One major constraint that limits sesame crop productivity is its extreme susceptibility to biotic and abiotic stresses (Yadava *et al*., 2012). Among the various biotic stresses, phyllody, charcoal rot and leaf curl are the highly destructive diseases of sesame. Sesame crop is attacked by several pathogens causing serious diseases which account for a worldwide annual loss of 7 million tones (Kolte, 2018). Phyllody is one of the most destructive diseases of sesame worldwide which is caused by a pleomorphic mycoplasma-like organism (phytoplasma) and transmitted by leaf hopper causing the affected plants become stunted, transforming the floral parts into green leaf-like structures (fig. 1) and causing yield loss up to 33.9 per cent or even 100% during severe incidence (Rao *et al*., 2017). Charcoal rot, another very important disease of sesame caused by soil-borne Deuteromycetes fungus *Macrcphomina phaseolina* (Tassi) Goid is widely distributed in all sesame growing areas of India including Uttar Pradesh, Rajasthan, Gujarat, Madhya Pradesh, Kerala, West Bengal, Tamil Nadu, Karnataka, Maharashtra and Haryana. Typical symptoms of charcoal rot are the dark and irregular lesions that appear on stem in the lower part with early defoliation, wilting and finally death of the whole plant (**fig. 2**). Charcoal rot leads to 5-60 % yield loss in all sesame crop growing areas (Meena *et al.,* 2018). However, some cultural practices such as application of systemic fungicides and soil solarization have been effective to some extent in reducing its ironic effects but due to the toxicity of fungicides and their harmful effects to the environment, cultivation of resistant varieties is the best strategy for disease control (Waard *et al.*, 1993). Sesame leaf curl virus disease is considered to be caused by whitefly (*Bemisia tabaci* L.) transmitted Gemini-virus (Mahmoud, 2013) and causes severe leaf curling, reduction in leaf size and stunted growth owing to which the affected plants bear scanty capsules having poor seed setting (**fig. 3.**) that results in reduced productivity in most severely affected crops (Sarwar and Akhtar, 2009). To make the cultivation of sesame more gainful, it is imperative and entirely necessary to breed cultivars having high yield potential along with inbuilt resistance against major diseases. Disease resistant varieties offer the only economic and eco-friendly approach to farmers for sustainable crop production and keeping crop production safe from epiphytotic attack (Khan *et al*., 2020). Recently, the development of resistant varieties as a means of controlling disease infection has become an important objective in almost all plant breeding programmes (Russell, 1978). Identification of new sesame genotypes resistant to major diseases is more beneficial, sustainable and safe approach to control sesame diseases and reduce its yield loss (Gupta *et al.,* 2018). Therefore, the present investigation was planned to evaluate 24 sesame genotypes under natural field conditions for their response to major diseases of sesame *viz*., phyllody, charcoal rot and leaf curl virus disease.

The present investigation of screening sesame genotypes against its major diseases *viz*., phyllody, leaf curl virus disease and charcoal rot was carried out at Research Farm of DLA Unit, Department of Agronomy, CCS Haryana Agricultural University, Hisar during the *Kharif* season, 2016 under natural field conditions. Twenty-four genotypes of sesame were obtained from Oilseeds section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, Haryana. All these genotypes were grown in five rows of 4m length in Randomized Complete Block Design (RBD) in 3 replications with row to row spacing 30 cm and keeping 10 cm plant to plant distance. All the recommended package of practices for dryland agriculture was followed to raise a good crop except that no chemical treatment was given for control of the above-mentioned diseases. The disease incidence was recorded at the time of reproductive phase (near physiological maturity) by counting the number of diseased plants and total plants observed by taking fifty plants per genotype in each replication. Scoring was done based on visual disease symptoms of these three diseases *viz*., phyllody (**fig. 1**), charcoal rot (**fig. 2**) and leaf curl disease (**fig. 3**). The visual symptoms of the given disease were also compared with the symptom given in the standard literature. The disease incidence (%) was calculated by using the following formula and reactions were graded in the categories as given in **Table 1**:

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plant observed}} \times 100$$

Table 1. Scale used for screening of genotypes for disease reaction

Disease Reaction	Disease Incidence (%)
Immune (I)	0
Resistant (R)	1-10
Moderately Resistant (MR)	11-20
Moderately Susceptible (MS)	21-40
Susceptible (S)	41-60
Highly Susceptible (HS)	> 60

Phyllody disease incidence ranged from 4.33 % to 15.63 %. The check variety HT 1 and HT 2 recorded 10.63 % and 12.40 % phyllody disease incidence, respectively. Meena *et al.* (2018) also reported that the phyllody incidence ranged from 8.7 % to 16.3 % while Min and Toyota (2019) reported phyllody disease incidence ranged from 5 % to 30 % with an average of 14 %. Genotype Shekhar had the highest phyllody incidence (15.63 %) and the lowest was observed for RT 125 (4.33 %). The overall mean phyllody incidence was recorded as 8.73 %. Genotypes viz., RT 125, HT 15, HT 20, JLS 110-12, OC 251, HT 24, RT 54, Pragati, NC 187, HT 9913, HT 9907, T 78, HT 45, KMR 60, HT 9316, HTC 1 (black) and KMR 41 were found resistant against phyllody disease (**Table 2**) which might serve as resistant source against phyllody for future sesame breeding programme. Singh *et al*. (2007) also reported that the genotype Pragati was resistant to phyllody. The genotypes *viz*., CST 2001-9, OC 201, Shekhar, TKG 22, HT 2000, HT 1 and HT 2 were moderately resistant to phyllody disease while none of the genotypes were found immune. Resistant genotypes developed infection at later stages and showed a minor severity as disease incidence was restricted to the top portion of plants. Several workers had previously reported about the resistance sources against phyllody of sesame. Mahadeva prasad *et al*. (2017) reported two genotypes viz., KAU-05-2-12 and PC-14-2 as resistant against phyllody with disease incidence of 4.61 and 5.39 per cent respectively. Palanna *et al.* (2015) reported GT-1 and DS-9 genotypes as resistance source to phyllody while Manjunatha (2010) reported that the genotypes namely IVT-09-1, IVT-09-2, IVT-09-14, IVT-09-19 and Kanakapura-1 showed resistance reaction against phyllody. Akhtar *et al.* (2013) reported four genotypes of sesame viz., NS98002-04 (phyllody incidence = 3.25%), NS98003-04 (phyllody incidence = 3.25%), NS99005-01 (phyllody incidence = 3.75%) and NS01004-04 (phyllody incidence = 10.0%) were resistant against phyllody in Pakistan.

Fig. 1. Symptoms of sesame phyllody in the field; (A) The entire sesame inflorescences are replaced by short twisted leaves closely arranged on top of the stem with very short internodes but leaves on the lower part of infected plant did not exhibit any visible symptoms (B) Floral virescence and dark exudates appears on foliage floral parts (C) Floral virescence

Fig. 2. Field symptoms of sesame charcoal rot; **(A)** Infected sesame plant showing charcoal rot symptoms on lower portion of the stem **(B)** Severe Charcoal rot infection leads to stem breakage **(C)** Root portion showing typical charcoal rot symptoms and devoid of lateral and finer roots

Leaf curl virus disease incidence ranged between 0 to 10.37 % in the present study. Sarwar and Akhtar (2009) observed sesame leaf curl disease incidence ranged between 2% to 8% under natural field conditions. Genotype NC 187 had the highest leaf curl disease incidence (10.37 %). The overall mean was 1.85 %. In the present investigation, 11 genotypes viz., RT 125, OC 201, OC 251, HT 9913, TKG 22, HT 9907, T 78, KMR 60, HT 1 (LC), HT 2 (LC) and KMR 41 were found immune against leaf curl disease and genotypes *viz*., CST 2001-9, HT 15, HT 20, JLS 110-12, HT 24, RT 54, Shekhar, HT 2000 and HT 45 were found resistant against leaf curl disease, while genotype NC 187 was moderately resistant to leaf curl disease. The 24 sesame genotypes evaluated during present study showed the lower variation for leaf curl disease incidence (%) (**Table 2**). Similar to our study, low incidence (%) of leaf curl disease in sesame was also observed in the previous study of Min and Toyota (2019).

Charcoal rot disease incidence ranged between 2.33 % to 31.28 % with an overall mean of 14.29 %. Genotype KMR 41 had the highest charcoal rot incidence (31.28 %) while the lowest was observed in KMR 60 (2.33 %). Min and Toyota (2019) reported charcoal rot disease incidence ranged from 10 % to 30 % with an average of 20 %. Genotypes *viz*., JLS 110-12, NC 187, HT 9913, TKG 22, T 78, HT 45, KMR 60 and HT 2 (LC) were found resistant to charcoal rot. Breeders may use them as source of resistance in breeding programmes. Genotypes *viz*., CST 2001-9, RT 125, OC 251, Shekhar, HT 9907, HT 2000,

Fig. 3. Symptoms of sesame leaf curl virus disease; **(A)** Severely infected sesame plant showing leaf curling and plant stunting **(B)** Close look of sesame twin with severe curling along with thickening of leaves **(C)** Underside of an infected sesame leaf showing vein swelling and upward curling along with leaf thickening

Table 2. Disease incidence (%) of Phyllody, Leaf curl virus and Charcoal rot disease in different genotypes of sesame

Genotypes	PHYLLODY DISEASE		LEAF CURL VIRUS DISEASE		CHARCOAL ROT DISEASE	
	Disease incidence (%)	Disease Reaction	Disease incidence (%)	Disease Reaction	Disease incidence (%)	Disease Reaction
CST 2001-9	14.97	MR	4.13	R	11.26	MR
RT 125	4.33	R	0.00	I	13.00	MR
HT 15	8.27	R	0.90	R	21.03	MS
HT 20	8.83	R	3.63	R	23.37	MS
OC 201	13.43	MR	0.00	I	29.03	MS
JLS 110-12	8.50	R	4.30	R	8.49	R
OC 251	5.13	R	0.00	I	13.77	MR
HT 24	7.47	R	1.90	R	27.12	MS
RT 54	6.37	R	1.33	R	16.33	MR
Pragati	8.43	R	4.83	R	17.86	MR
NC 187	9.43	R	10.37	MR	6.00	R
Shekhar	15.63	MR	6.30	R	10.57	MR
HT 9913	7.87	R	0.00	I	8.61	R
TKG 22	10.40	MR	0.00	I	7.67	R
HT 9907	7.27	R	0.00	I	15.83	MR
T 78	5.27	R	0.00	I	4.47	R
HT 2000	11.47	MR	5.33	R	11.73	MR
HT 45	6.93	R	2.00	R	6.00	R
KMR 60	8.80	R	0.00	I	2.33	R
HT 9316	4.50	R	0.00	I	10.97	MR
HT 1 (LC)	10.67	MR	0.00	I	14.91	MR
HT 2 (LC)	12.40	MR	0.00	I	6.38	R
HTC 1 (black)	5.83	R	1.63	I	25.03	MS
KMR 41	7.27	R	0.00	I	31.28	MS
Mean	8.73		1.85		14.29	
Range	4.33-15.63		0.0-10.37		2.33-31.28	
LSD	1.97		0.85		7.01	
SE(m)	0.69		0.30		2.46	

I = Immune, R = Resistance, MR = Moderately Resistance, MS = Moderately Susceptible, S = Susceptible, HS = Highly Susceptible, LSD = Least Significant Difference ($P \leq 0.05$)

HT 9316 and HT 1 were found moderately resistant to charcoal rot disease; while genotypes, namely, HT 15, HT 20, OC 201, HT 24, HTC 1 (black) and KMR 41 were moderately susceptible to charcoal rot disease. None of the genotypes were found immune (**Table 2**). This result is in agreement with Farooq *et al.* (2019), whereas he reported that sesame genotype 87008 showed a resistance reaction against charcoal rot with 1-10 % mortality range whereas genotypes 87502 and 95002 were moderately resistant and the genotypes *viz*., 20011, black till, TS3 and 98002 were susceptible against the charcoal rot and none of the variety/line was immune against charcoal rot. Development /identification of disease resistant plant varieties/lines is the key objective for crop breeders and geneticists after high seed yield. The results of present study indicated the presence of sufficient variation among all the genotypes with respect to all the three diseases under study *viz*., phyllody, charcoal rot and leaf curl virus disease. Out of 24 sesame genotypes studied, only four genotypes namely JLS 110-12, HT 9913, T 78 and KMR 60 were found to possess multiple disease resistance with 0-8.80 % disease incidence against aforementioned diseases except HT 9913, T 78 and KMR 60 which showed 0% disease incidence and were immune against leaf curl disease. Our study concludes that these resistant genotypes might be very useful sources for introgression of multiple resistance genes/QTLs into agronomically more desirable genetic background for developing disease resistant high yielding cultivars. However, further evaluation of these resistant genotypes is still needed over different locations and/or years to validate them as multiple disease resistance source.

REFERENCES

Akhtar, K.P., Sarwar, G., Sarwar, N. and Elahi, M.T. 2013. Field evaluation of sesame germplasm against sesame phyllody disease. *Pak. J. Bot*., **45**(3): 1085-1090.

Biswas, S., Natta, S., Ray, D.P., Mondal, P. and Saha, U. 2018. Til (*Sesamum indicum* L.)-An underexploited but promising Oilseed with multifarious applications: A Review. *Int. J. of Bioresource Sci.,* **5**(2): 127-139. [Cross Ref]

Farooq, S., Mohyo-Ud-Din, A., Naz, S., Siddique, M. and Khan, S.N. 2019. Screening of sesame (*Sesamum indicum* L.) germplasms for resistance against charcoal rot disease caused by *Macrophomina phaseolina* (Tassi) Goid. *Int. J. Biol. Biotech*., **16**(2): 407-410.

Gupta, K.N., Naik, K.R. and Bisen, R. 2018. Status of sesame diseases and their integrated management using indigenous practices. *Int. J. Chem. Stud*., **6**(2): 1945-1952.

Khan, A.H., Hassan, M. and Khan, M.N., 2020. Conventional Plant Breeding Program for Disease Resistance. In *Plant Disease Management Strategies for Sustainable Agriculture through Traditional and Modern Approaches* (pp. 27-51). Springer, Cham. Switzerland. [Cross Ref]

Kolte, S.J. 2018. *Diseases of Annual Edible Oilseed Crops: Volume II: Rapeseed-Mustard and Sesame Diseases*. CRC press. [Cross Ref]

Mahadeva prasad, T.N., Karuna, K., Jayashree, M.K. and Reddy, K.S. 2017. Research note field evaluation of sesame lines against phyllody. *Electron. J. Plant Breed.,* **8**(3): 945-949. [Cross Ref]

Mahmoud, M.F. 2013. Induced plant resistance as a pest management tactic on piercing sucking insects of sesame crop. *Arthropods,* **2**(3): 137.

Manjeet, Verma, P.K., Sheoran, R.K., Nain, M. and Avtar, R., 2020. Evaluation of sesame (*Sesamum indicum* L.) genotypes for genetic variability based on different traits under rainfed conditions. *Electron. J. Plant Breed*., **11**(1): 54-59. [Cross Ref]

Manjunatha, N. 2010. Molecular detection and characterization of sesame phyllody phytoplasma. *M.Sc. (Agri.) Thesis*, Univ. Agri. Sci., Bengaluru, India. pp.12

Meena, B., Indiragandhi, P. and Ushakumari, R. 2018. Screening of sesame (*Sesamum indicum* L.) germplasm against major diseases. *J. Pharmacogn. Phytochem.,***7**(1S): 1466-1468.

Min, Y.Y. and Toyota, K. 2019. Occurrence of different kinds of diseases in sesame cultivation in Myanmar and their impact to sesame yield. *J. Exp. Agric. Int.,* pp.1-9. [Cross Ref]

Palanna, K.B., Shivanna, B., Boraiah, B., Pappachan A. and Nagaraj, M.S. 2015. Evaluation and screening of sesamum varieties against sesamum phyllody and its incidence and severity in central dry zone of Karnataka. *Green farming,* **6**(5): 1130-1133.

Pathak, N., Rai, A.K., Kumari, R., Thapa, A. and Bhat, K.V. 2014. Sesame crop: an underexploited oilseed holds tremendous potential for enhanced food value. *Agric. Res.,* **5**(6): 519. [Cross Ref]

Rao, G.P., Madhupriya, T.V., Manimekalai, R., Tiwari, A.K. and Yadav, A.2017. A century progress of research on phytoplasma diseases in India. *Phytopathogenic Mollicutes,* **7**(1): 1-38. [Cross Ref]

Russell, G.E. 1978. General principles and methods of breeding for resistance. *In Plant breeding for pest and disease resistance: studies in the agricultural and food sciences* (pp. 15-41). Butterworth-Heinemann, London, England. [Cross Ref]

Şahin, S. and Elhussein, E.A.A. 2018. Assessment of sesame (*Sesamum indicum* L.) cake as a source of high-added value substances: from waste to health. *Phytochem. Rev.,* **17**(4):691-700. [Cross Ref]

Sandhiya, V., Kumar, M., Parameswari, C., Vanniarajan, C., Kumaravadivel, N., Sakthivel, N. and Badigannavar, A.M. 2020. Determination of optimum dose of chemical mutagen for large scale seed treatment of white seeded sesame (*Sesamum indicum* L.) varieties. *Electron. J. Plant Breed.*, **11**(1): 238-242. [Cross Ref]

Sarwar, G. and Akhtar, K.P. 2009. Performance of some sesame mutants to phyllody and leaf curl virus disease under natural field conditions. *Pak. J. Phytopathol.*,**21**(1): 18-25.

Singh, M., Avtar, R., Pal, A., Punia, R., Singh, V.K., Bishnoi, M., Singh, A., Choudhary, R.R. and Mandhania, S. 2020. Genotype-Specific Antioxidant Responses and Assessment of Resistance Against *Sclerotinia sclerotiorum* Causing Sclerotinia Rot in Indian Mustard. *Pathogens*, **9**(11): 892. [Cross Ref]

Singh, P.K., Akram, M., Vajpeyi, M., Srivastava, R.L., Kumar, K. and Naresh, R. 2007. Screening and development of resistant sesame varieties against phytoplasma. *B. Insectol.,***60**: 303-304.

Waard, M.A., Georgopoulos, S.G., Hollomon, D.W., Ishii, H., Leroux, P., Ragsdale, N.N. and Schwinn, F.J. 1993. Chemical control of plant diseases: problems and prospects. *Annu. Rev. Phytopathol.*, **31**(1): 403-421. [Cross Ref]

Yadava, D.K., Vasudev, S., Singh, N., Mohapatra, T. and Prabhu, K.V.2012. Breeding major oil crops: Present status and future research needs. In technological innovations in major world oil crops (Volume I). :17-51. Springer, New York. [Cross Ref]