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Sesame phyllody disease: Its symptomatology, etiology, and transmission

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Abstract
Sesame or Til (*Sesamum indicum* L.) belongs to family Pedaliaceae is one of the principal oilseeds in common use in India. Among the several diseases infecting sesame. Phyllody is a serious disease of sesame (*Sesamum Indicum* L.,) in India. In the present study investigations were carried out on the etiology and transmission of this disease. The major symptoms of the disease are phyllody, witch`s broom, floral virescence, thickening of veins, twisting of stem, deformation of capsule, severe reduction in leaf size, early drying of the plant were noticed. Under severe condition cracking of seed capsule, germination of seeds within capsule, and floral malformation like abnormal green structures in place of normal flowers were also noticed. Light microscopy of handout section of sesame stems treated with dienes stain should blue area in the phloem region of phyllody infected plants. Sesame phyllody was successfully transmitted through side grafting from donor sesame to healthy sesame and produced typical phyllody symptoms within 35-40 days. Sesame phyllody was successfully transmitted from sesame to sesame by grafting. The phytoplasma causing the sesame phyllody disease had a limited host range and it was transmitted to sesame by leaf hopper and to periwinkle by grafting. The phytoplasma produced phyllody on sesame and floral virescence with an increased number of axillary shoots and smaller leaves after transmission and little leaf on periwinkle. In both cases typical symptoms of plants were obtained. Transmission of phytoplasmas from naturally infected plant host species using the parasitic plant *Cuscuta* spp. (dodder) The sesame phyllody phytoplasma was also successfully transmitted by dodder and sesamum phyllody cannot transmit through seed and sap.

Keywords: Phylody, *Sesamum indicum*, phytoplasmas

Introduction
Sesame (*Sesamum indicum* L.) is one of the important oldest oil seed crop grown in tropical and subtropic and it is also known by queen of oil Seed in India. It belongs to family Pedaliaceae is native of India and plays an important role in the oilseed economy throughout the world. Sesame seed is a rich source of protein (20%) and edible oil (50%), and contains about 47% oleic acid and 39% linolenic acid (Shyu and Hwang, 2002) [20, 3]. Sesame oil has excellent stability due to the presence of the natural antioxidants sesamoline, sesamin and sesamol. Oil from sesame seeds is used in cooking, salad preparation, and margarine; while sesame seeds are used in baking, candy, and in other food industries. India is among the top five countries of the world in oilseed production which is estimated to be 25.5 million tonnes annually. Nine edible oilseeds are cultivated in India and sesamum ranks fifth in production, after groundnut, rape seed, soybean and sunflower (Chattopadhaya *et al*., 2015) [6]
The sesame crop suffers from many diseases (Gupta *et al*., 2018) [13] like powdery mildew caused by *Erysiphe cichoracearum* (Natarajan *et al*., 1983) [16], Stem and Root rot caused by *Macrophomina phaseolina* (Mihail, 1995) [15], Phytophthora blight (*Phytophthora parasitica* var.*sesami*), Alternaria leaf spot caused by *Alternaria sesame* (Mehta and Prasad, 1976[14] and Dolle, 1981[10]), Cercospora leaf spot, Fusarium wilt, bacterial blight (*Xanthomonas Compestris* pv. *sesami*) (Cook, 1981) [8]. Bacterial leaf spot (*Pseudomonas syringe* p.v. *sesame* (Cook 1981) [20] and phyllody caused by phytoplasma.
Mycoplasma like organisms (MLOs) has been found to be associated with diseases in several hundred plant species. Doi *et al.*, (1967) [9] first discovered the presence of cell wall less prokaryotes with in sieve cells of plants exhibiting yellow symptom. They are associated with diseases affecting hundreds of plant species and are transmitted by phloem sucking insects (Weintraub and Beanland, 2006) [21].
Sesame phyllody is transmitted by a leafhopper (*Orosius albicinctus*). Phytoplasmas are able to move within plants through the phloem from source to sink and they are able to pass

through sieve tube elements (Christensen, *et al*., 2004) [5]. Phytoplamas are pleomorphic and have small genome. In plants, they are restricted to the phloem tissue and spread throughout the plant by moving through the pores of the sieve plates which divide the phloem sieve tubes Plants Infected by Phytoplasma Exhibit a wide range of Specific and known specific symptoms. symptoms of diseased plants may vary with the phytoplasma, post plant, stage of the disease, age of the plants at the time of infection and environmental condition.

Materials and Methods

Transmission

Grafting Inoculation

Four week old sesamum plants were used for graft inoculation using Sesamum phyllody phytoplasma (Akhtar *et al*., 2009) [2] under net house conditions. For grafting, a sliced cut was made on the stem about 2-3 cm below the tip. About 13 cm long sesamum branch exhibiting typical phyllody symptoms was detached from an infected plant and a similar cut (as on the test plant) was made on this branch. The corresponding cut surfaces were tied together with parafilm. The grafted plants were kept inside humid chamber created artificially with the help of polythene bag and removed after 7 days. Altogether 10 plants were grafted and the grafted plants were observed daily for symptom development.

Sap Inoculation

For sap transmission sesamum plant tissues with typical Sesamum phyllody disease symptoms were collected and grinded in 0.02M phosphate buffer (pH 7.4) with mortar and pestle and then squeeze through very fine muslin cloth as described by Akhtar *et al.*, (2009) [2]. A pinch of Carborandum powder was sprinkled over the leaves to be inoculated to cause injury in the leaf tissues for the penetration of the Phytoplasma. Two young leaves from 4 week old healthy sesamum plants were mechanically inoculated with the freshly extracted sap using cotton pads. Inoculated leaves were rinsed with a gentle stream of water immediately after inoculation to remove superfluous inoculums and place in insect proof cages. Altogether 10 plants were used for sap inoculation and the inoculated plants were observed regularly for symptom development.

Seed transmission

Matured seeds from Sesamum phyllody infected and healthy sesamum plants were collected and stored in the laboratory. Twenty seeds each from diseased and healthy sesamum plants were raised on earthen pots inside insect proof cages. Germination percentage, number of plants showing symptoms and time taken for symptom development was observed until maturity.

Insect transmission

Healthy seeds of sesamum plants were sown in earthen pots and placed in insect free green house. Adult *Orosious albicintus* Dist. leafhopper from established leafhopper colonies maintained inside insect proof cages was used as vector for the transmission test. The leafhopper was first given acquisition feeding on the Sesamum phyllody infected plant for required period of time and then inoculation feeding access on the healthy sesamum plants. Inoculated plants were continuously monitored for symptom expression. Data on percent disease incidence, time required for first appearance of the symptoms were recorded.

Dodder transmission

The growing ends of the dodder (*Cuscuta reflexa* Rox.) collected from healthy fodder plants of Lucerne were twined to young growing shoots of infected sesame plants in anti-clock direction and the cut end was inserted in a test tube containing water. Subsequently growing end of the dodder was twined on the young shoots of 10 healthy test plants in anti-clock direction. The dodder so established was allowed to grow as bridge between infected sesame plant and test plants for 30 days and later it was removed, then the test plants were kept in insect proof glasshouse for symptom production. Observations were recorded on number of plants showing symptom and time taken for symptom development.

Results and Discussion

Transmission

Seed and Sap transmission

Seed and Sap transmission indicated that, the sesame phyllody phytoplasma could not be transmitted by infected seed. Out of Fifty phyllody (10 Bold smooth seed and 10 Shrivelled sunken seed) infected seed, no symptoms were observed on inoculated plants. The present results were in agreement with the results obtained by Akhtar *et al*., (2009) [2], Choopanya (1972) and Pathak *et al.*, (2012) [17]

Plant inoculated with sap extracted from sesame phyllody infected plants were also remained free from infection. Out of twenty plants inoculated with sap, no symptoms was observed in the plants. The present results were in agreement with the results obtained by Akhtar *et al*., (2009) [2], Choopanya (1972) [7] and Pathak *et al.*, (2012) [17]

Table 1: Sesamum Phyllody Transmission by Seed and Sap

S. No.	No. of Seed or No. Of plants inoculated	No. Of Seeds Generated or No. Of Plants Effected	% of Disease Transmission
1	Disease Seeds -50	38	-
2	Healthy Seeds-50	42	-
3	Plants -20	-	-

Transmission through Grafting

Sesame phyllody was transmitted successfully from infected plants to healthy plants through grafting. Out of twenty grafts inoculated plants four plants are showed phyllody symptoms 35-40 day after inoculation. The inoculated plants showed characteristic symptoms phyllody, floral virescence, yellowing of leaves and stunted growth. These results indicate that the 25 percent of disease transmitted into the graft inoculated plants. These similar results were also formed by earlier reported by the Akhtar *et al*., 2009) [2]. Sesame phyllody was also transmitted by sesame to periwinkle. Out of 10 plants one plant showed phyllody symptoms 35-40 day after inoculation. These results are advocated with the findings of Salehi and Izadpanah, (1991) [19], Akhtar *et al*., (2009) [2], Ravindar (2017) [18] and Gupta *et al*., (2015) [12]

Table 2: Sesame phyllody transmission by Grafting.

Donor plant	Receptor plant	Number of plants		Percent transmission
		Inoculated	Infected	
Sesamum	Sesamum	20	4	25
Sesamum	Periwinkle	10	1	10

Transmission through Dodder

The results indicated that the phytoplasma under study was transmitted by dodder from infected sesamum to healthy Sesamum plants. Out of the 10 plants, 2 plants were observed with phytoplasma symptoms after 35-40 days of inoculation. Earlier, Abraham *et al.*, (1977) [1] reported that dodder (*Cuscuta campestris*) played role for transmission, donor as well as reservoir of sesamum phytoplasma

Table 3: Sesame phyllody transmission by Dodder (*Cuscuta Spp*.)

Name of the vector	Number of plants		% of transmission
	Inoculated	Infected	
Dodder	10	2	20

Insect transmission

Sesamum phyllody phytoplasma was successfully transmitted from infected sesamum plants to healthy sesamum plants by the leafhopper vector (*Orosius albicinctus* Dist.) under net house condition. Successful transmission of Sesamum phyllody disease with the same vector was also reported (Akhtar *et al.*, 2009[2]; Pathak *et al.*, 2013[17]; Gogai *et al*., 2017[11] and Cengiz *et al.*, 2014) [4].

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