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Studies on phyllody disease of sesame (*Sesamum indicum* L.): Symptomatology and transmission

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Abstract
Sesame (*Sesamum indicum* L.) belongs to family pedaliceae, which have basic chromosome number 2n =26 and originated in India. It is oldest oilseed crop. High yield and quality of oil, sesame is often called as the "Queen of oil seeds". The crop is affected by sesame phyllody disease. In the study of symptomatology the main symptoms that observed in field were floral virescence, drying of effected phyllody flower, flower proliferation and appearance of witches broom etc. Investigations were carried out on the symptomatology of phytoplasma associated with phyllody disease. Out of the three transmission techniques studied *viz*., sap, seed and insect transmission result showed that sesame phyllody is a insect transmitted disease and the vector is *Orosius albinctius* with transmission (83.33%).

Keywords: Phyllody, phytoplasma, proliferation, Virescence and witches broom

1. Introduction
Sesame (*Sesamum indicum* L.) belongs to family pedaliaceae, which have basic chromosome number 2n =26 and originated in India. Sesame is an important annual oilseed crop which requires warm and hot climate and commonly grown under stressed condition from tropical to temperate region. Sesame is an annual, tall growing (1.0 to 1.5 meter) herbaceous plant which mature in about 90 to 110 days.

India ranks five in the world in oilseed production. Which is assumed to be 25.5million tonnes annually. In India, among all nine cultivated edible oilseeds, sesame ranks fifth in production, after groundnut, rape seed, soybean and sunflower (Chattopadhaya *et al*. 2015) [1].

Seeds of sesame is a rich source of protein and edible oil which is 20% and 50%, respectively and also contain a high amount of saturated fatty acids (47% oleic acid and 39% linolenic acid) and due to presence of some natural antioxidants such as sesamoline, sesamin and sesamol, sesame oil has very good stability (Moazzami *et al*. 2006) [13].

A sesame crop suffers from many fungal, viral, bacterial and phytoplasma diseases. The diseases such as Phytopthora blight (Butler,1918) [3], Root rot (Mehta,1951) [12], Bacterial blight (Rao,1962; kolte,1985; Vyas *et al.* 1984) [17, 9, 20], Bacterial leaf spot (Vyas *et al.*1984; kolte,1985) [20, 9], Cercospora leaf spot (kolte,1985) [9], Alternaria leaf spot (Kolte, 1985) [9], Powdery mildew (Rajpurohit, 1993) [15], Phyllody (Gibbion MC,1924; Kashiram, 1930) [7] etc.

Among all the above mentioned diseases phyllody is a severe disease of sesame which causes a major loss in crop yield in most of the crop growing region, chiefly in warm areas (Manjunath, 2012).

Phytoplasma are prokaryotic, wall less organism and phloem restricted which belonging to the class Mollicutes (Lee *et al.* 2000) [10]. They are correlated with diseases affecting hundreds of plant species and are transfer by phloem sucking insects (Weintraub and Beanland, 2006) [21].

Sesame phyllody was first reported in Burma (Myanmar) and was nominate as "*Green flowering disease/ Pothe*" (Gibbon MC, 1924) [4]. Later, it was reported in India as plant appear phyllody such as symptoms and was called filamentous Phytoplasma diseases reported in many crops like cereals, oilseeds, ornamentals, fruits, vegetables, plantations, weeds and spices crops also. In phytoplasma diseases phyllody is important disease which is observed on many host plant in which sesame, chickpea, brinjal, mungbean, pigeon pea, parthenium and black paper are commonly remark host plant which is infected by phytoplasma phyllody disease. First report of phytolasma as plant pathogens responsible for yellows disease (Doi *et al*. 1967) [2]. Phytoplasma are covered by single unit membrane, lacking rigid cell wall, pleomorphic in shape with average diameter of 0.2 – 0.8µm and transmitted is mainly occur

by sap sucking insect vectors belonging to families Cicadellidae (Leaf hopper) and Fulgoridae (Plant hopper). Transmission of sesame phyllody disease is occurred by leaf hopper (*Orosius albicinctus*), grafting and dodder. There is no transmission by sap.

2. Materials and Methods

2.1 Symptomatology

The symptomatology of phyllody disease on naturally infected plants was studied on farmer's field as well as experimental plot. The observations were recorded on infected floral part (Inflorescence, leaves, Stem and Capsules).

2.2 Transmission Studies of sesame phyllody

2.2.1 Sap Transmission

Sesame plant tissues with typical phyllody disease symptoms were collected and grind in 0.02 M Phosphate buffer (pH 7.0) with a mortar and pestle, and then squeezed through very fine muslin cloth. Young leaves from ten 4-week-old healthy sesame plants were dusted with 500-mesh carborandum powder and mechanically inoculated with the freshly extracted sap using cotton pads. Plants were rinsed with a gentle stream of water immediately after inoculation to remove superfluous inoculums and placed in insect-free cages for symptom development.

2.2.2 Seed Transmission

For seed transmission, the seeds were collected from sesame phyllody infected sesame plants of susceptible cultivars in previous year. Collected seeds were sown in pots containing soil and compost mixture. Pots are maintained in insect proof green house. For determining the level of seed transmission, number of infected plants by seed transmission was counted in total population sown.

2.2.3 Insect Transmission

For insect transmission *Orosius albicinctus* Dist. species used in transmission tests, were collected from sesame field. Collected leaf hopper was placed in transmission cage. For raising vector colony the infected leaves of sesame were placed in transmission cage. Transmission cage were closed for 24 hour, after 24 hour collected leaf hopper were released in healthy 25 sesame plant in pots raised young sesame plants, covered with a muslin cloth as well as individual healthy plant and covered by big transmission cages. Later after 21 day leaf hoppers were killed by spraying with imidacloprid insecticide. Test plants were maintained in an insect proof cage house. Observation on symptom development was recorded with respect number of plant produce phyllody symptoms and time taken for phyllody symptom development.

3. Results and Discussion

3.1 Symptomatology

Different types of phyllody symptoms were observed on sesame plants grown under experimental field conditions. The major disease symptoms was observed in field were depicted in different plates *viz.*, floral virescence (Plate 1a), flowers converted into leaf like structure (Plate 1b), drying of affected phyllody flower (Plate 1c), floral proliferation (plate 1d), stunting growth of infected plant (Plate 2a), witches broom (Plate 2b), sepal and petal converted into leaf like structure (Plate 2c)

It was observed that the most characteristic symptoms of the disease is transformation of reproductive organs into green leafy structures followed by abundant vein clearing in different floral parts. In severe infection the entire floral inflorescence is replaced by small leaves closely arranged in nearby stem with very short nodes and internodes and affected plants become stunted. Ultimately whole plants look like broom shaped or we can say witches broom.

3.2 Sap Transmission

Sap transmission experiment was carried out, by using mechanical inoculation of the sap young plant of sesame at 3-5 leaf stage induced to disseminate of the phytoplasma (vide method-2.1). The inoculated plants did not produce any typical phyllody symptoms during the observation period up to the maturity. The result clearly indicated that this disease is not transmitted through sap inoculations or could not be transmitted mechanically when inoculations were made (vide method-2.1) in 0.1 M phosphate buffer at pH 7.0 (Table 1).

3.3 Seed Transmission

Seed transmission experiment was carried out, by using sesame phyllody infected seeds (vide method-2.2) and results obtained are presented in Table 1. Result indicated that, growing of sesame phyllody infected seeds (collected previous year) as well as healthy seeds do not produced phyllody symptoms till maturity in plant grown under insect proof conditions, hence it shows that this disease is not seed transmitted or seed borne in nature. Phyllody of sesame could not be transmitted through seeds. Sap transmission experiment was carried out, by using mechanical inoculation of the sap young plant of sesame at 3-5 leaf stage induced no transmitted of the phytoplasma. The inoculated plants did not produce any typical phyllody symptoms during the observation period up to the maturity. The result clearly indicated no mechanical transmissibility of phytoplasma.

Seed transmission experiment was carried out, by using sesame phyllody infected seeds and result indicated that, growing sesame phyllody infected seeds do not produced phyllody plant and seed transmission rate is zero per cent. Result indicated that sesame phyllody disease is not transmitted by seed and not seed borne.

Similar results regarding on sap and seed transmissions also reported by different workers. Akhtar *et al.* (2009a) studied transmission of sesame phyllody and reported that, seed and sap transmission could not achieve. It indicated that, sesame phyllody is not mechanically transmitted. They also reported that, disease is transmitted successfully from infected to healthy plant via. Grafting, dodder, leaf hopper (*Orosius albicinctus*).

Omidi *et al.* (2010) [14] studied that, transmission status of *Orosius albicinctus* as a natural vector of phytoplasma, leaf hopper collected from potato, alfalfa, sesame field and caged on periwinkle plant the plant showing phyllody symptoms such as Virescence, study reported that, phytoplasma were transmitted by leaf hopper from infected to healthy host plants.

Tan (2010) [18] studied various phyllody infected sesame variety for seed transmission of sesame phyllody disease in natural condition, seed from infected phyllody plant are sown out of which no any plant produce phyllody symptoms, study reported that, phyllody disease of sesame is not seed transmitted, also reported that, disease is not seed borne in nature.

Karra (2017) [6] studies, sesame phyllody disease could not

transmit through sap and seed. This indicates that the sesame phyllody cannot transmit through seed and sap. Out of the twenty inoculated plants with sap, no symptoms were observed on inoculated plants. Out of twenty sap inoculated plants, no one is showed positive reaction in PCR assay.

Vamshi *et al.* (2019) [19] study investigations were carried out on the transmission and molecular characterization of phytoplasma associated with phyllody. Phyllody disease was successfully transmitted by grafting infected sesame scion to periwinkle stock.

The grafted periwinkle plants exhibiting yellowing of leaves and floral virescence was analyzed by PCR to confirm the transmission of phytoplasma from phyllody infected sesame scion to healthy plants. It was clearly indicated that the disease is not transmitted through the seeds collected from phyllody infected sesame plants.

3.4 Insect Transmission: As per information mention in material and methods transmission studies were carried out. The leaf hopper vector was identified to be *Orosius albicinctus* Dist. (Plate-4). The result on insect transmission studies was presented Table 2. and Plate 4 indicated that, sesame phyllody disease was successfully transmitted by using insect vector leaf hopper *Orosius albicinctus* Dist. (vide method-2.3).

The result on insect transmission studies was indicated that, sesame phyllody disease was successfully transmitted by using insect vector leaf hopper. The leaf hopper vector *was* identified to be *Orosius albicinctus* Dist.

Similar results also reported by Manjunatha *et al*. (2012) [11], Khabbaz *et al*. (2013) [8], Itken *et al.* (2014) [5], Rao *et al*. (2015) [16] worked on the phyllody of sesame and reported that, *Orosius albicinctus* Dist. was the most predominant insect species in most infected sesame fields, which play an important role in transmission of the phytoplasma.

Table 1: Sesame phyllody transmission by sap and seed

S. No.	No. of Seeds or No. of plants inoculated	No. of seeds Germinated	No. of plants Showing typical Phyllody symptoms	Seed transmission (%)
1	Disease seed – 55	40	00	00
2	Healthy seed – 55	50	00	00
3	Plant – 25 (for sap transmission)	25	00	00

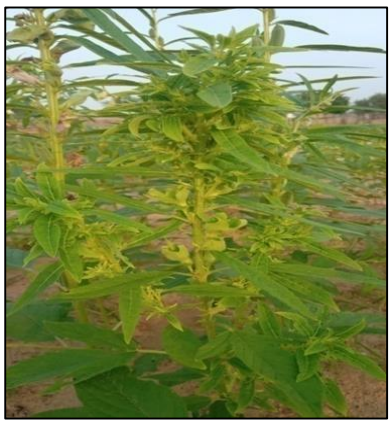
Table 2: Insect Transmission of Sesame Phyllody

Type of Transmission	Host Plant	No. of plant used for transmission	No. of plant produce phyllody symptoms	Transmission percent (%)
Insect Transmission	Sesame	30	25	83.33

2a Floral Virescence

2b Flower converted into leaf

2c Drying of affected flower

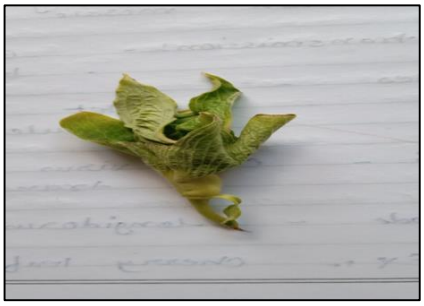


3a Stunting of growth

Plate 1: Symptoms produced in experimental field

3a Stunting of growth

3b Witches broom



3c Sepals and Petals are converted into leaf like structure

Plate 2: Symptoms observed in experimental field

Infected flowers

Healthy flowers

Plate 3: Comparison between infected flowers and healthy Sesame flowers

Insect transmission

Leaf hopper feeding on Sesame plant Phyllody symptoms after Insect transmission

Plate 4: Insect Transmission of Sesame Phyllody

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