

Sterility Mosaic Disease (SMD) in Pigeonpea: Emerging Challenges, Current Status, and Integrated Management Strategies

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Abstract

Pigeonpea is the major pulse crop grown in India, predominantly during the kharif season, both as a sole crop and as an intercrop, though found in a wide range of agro-ecological situations. Playing a crucial role in the economic well-being of subsistence farmers, the yield of redgram is limited by several factors, including agronomic, pathogenic, entomological, and genetic factors, as well as their interaction with the environment. Sterility mosaic disease (SMD), caused by Pigeonpea sterility mosaic virus (PPSMV) and transmitted by the Eriophyid mite (*Aceria cajani*), is a significant constraint to pigeonpea cultivation in the Indian subcontinent, leading to potential yield losses of up to 100%. This article focuses on the current status of the disease, transmission, and host range, as well as available management strategies.

Keywords: Pigeonpea, Redgram, Sterility Mosaic Disease, SMD, Eriophyid mite, Management

Introduction : Pigeon pea is the most versatile grain legume crop grown in the semiarid tropical and subtropical regions in Asia, Africa, and America. According to the department of Agriculture & Farmers Welfare, Ministry of Agriculture, New Delhi the World major pigeonpea producing countries are India (42.20 lakh tonnes), Malawi (4.47 lakh tonnes), Myanmar (3.27 lakh tonnes), Tanzania (1.64 lakh tonnes) and Kenya (0.83 lakh tonnes). In India, the area under this crop reported during 2025-26 was 42.42 lakh ha (104.82 lakh acres) as against 46.50 lakh ha (114.90 lakh acres) during the same period in 2024-25. In India, major pigeonpea cultivating states are Karnataka 12.62 lakh ha (31.18 lakh acres), Maharashtra 10.83 lakh ha (26.76 lakh acres), Madhya Pradesh 3.70 lakh ha (9.14 lakh acres), Uttar Pradesh 3.33 lakh ha (8.23 lakh acres), Telangana 1.99 lakh ha (4.92 lakh acres) and Gujarat 1.94 lakh ha (4.79 lakh acres).

Pigeonpea is the major pulse crop grown in India, predominantly, during kharif season both as a sole crop and as an intercrop with soybean, cotton and maize, though found in wide range of agro-ecological situations. The yield of Pigeonpea is limited by a number of factors such as agronomic, pathogenic, entomological, genetic and also their interaction with the environment. Low productivity is caused by a combination of poor crop management, including incorrect sowing times, faulty agronomic practices, and biotic and abiotic stresses. Specific issues include pest and disease outbreaks, nutrient deficiencies, poor quality seeds, erratic rainfall, and the cultivation of low-yielding local varieties.

Pests have a significant economic impact on red gram (pigeon pea) production, causing substantial yield losses (estimated at 30-80% annually) and increasing production costs through management efforts. The major impacts include direct yield reduction, lower market value of damaged produce, and increased farming expenses. According to various reports, pigeon pea was infested by at least 150 - 250 species of pests among which Sterility Mosaic Disease (SMD) transmitted by mite is one of the important biotic constraints.

Nature & extent of Damage by SMD : Sterility mosaic disease (SMD) has a significant negative economic impact on pigeonpea production, causing substantial yield losses, potentially up to 100% in severe cases, and

reducing the quality of the harvest. It is considered the most important viral disease of pigeonpea in the Indian subcontinent, with estimated annual losses exceeding \$300 million in India alone.

SMD of pigeonpea was first reported in Bihar State, India in the year 1931 and since then it has evolved into a serious problem for pigeonpea cultivation in India, leading to an annual loss of over US\$300 million. Though SMD is endemic to India and it has been reported from Bangladesh, Nepal, Thailand, Myanmar, Sri Lanka and China, in India, SMD is reported in And-Pradesh, Bihar, Chhattisgarh, Gujarat, Karnataka, Maharashtra, Punjab, Tamil Nadu, Telangana, Uttar Pradesh and West Bengal.

Sterility mosaic disease (SMD) is an emerging biotic risk to the cultivation of pigeonpea throughout the Indian subcontinent. The Chittoor district of Andhra Pradesh, Medak Ranga Reddy and Sanga Reddy districts of Telangana, Bijapur district of Karnataka, and Latur district in Maharashtra states were found to be vulnerable to SMD occurrence in the future. Based on the interpolation results, the potential SMD hotspots/risk areas were most prominent in Telangana, Andhra Pradesh, Karnataka, and Tamil Nadu states. These identified hotspots for SMD revealed high levels of disease probability rates (>25%) above the threshold level and must be closely monitored to restrict and minimize further disease spread in Southern India.

Recent reports point out an increase in the incidence of SMD in recent years due to shifts in the cropping systems, the rapid spread of viruliferous mites that transmit virus inoculum, the adjacency of new fields to already infected fields, and conducive environmental factors supporting eriophyid mite development and cultivar susceptibility, resulting in extreme economic yield losses. Moreover, infection predisposes the crop to successive infection by pathogenic fungus and establishment by tetranychid spider mites. Due to SMD, crop losses vary largely and further depend on the cultivar and infection phase, i.e., SMD infection at the vegetative phase can lead to a yield loss of between 26 and 97%. Although there are conflicting ideas about the impact of climate factors on SMD distribution, plants grown under irrigation are highly susceptible to initial stage infection by SMD due to high colonization of eriophyid mites.

Symptoms of Damage by SMD : SMD appears as a yellow mosaic, with bushy pale green plants exhibiting excessive vegetative growth, reduced leaf size, stunting, leaf distortion, and partial or complete cessation of reproductive parts. Infected plants also show a significant reduction in plant height, number of branches and flowers per plant, and pod length. SMD is known to be the “Green Plague” of pigeonpea, as the diseased plants show lush greenery with excessive vegetative growth without flowers and seed pods and it spreads like a plague in an epidemic form. The nature and severity of symptoms depend on the genotype and stage of infection.

In susceptible genotypes, early-stage infection i.e. in around 45-day old plants it results in the development of characteristic symptoms and complete cessation of flowering (sterility), while later-stage infection i.e. >45-day old results in delayed symptom expression with mild mosaic on few branches or on the part of the branch, reduced flowering and partial sterility. Based on severity, the disease symptoms can be categorized into three groups: (i) severe mosaic and sterility, (ii) mild mosaic and partial sterility, and (iii) chlorotic ring spots with no sterility.

The extent of damage by SMD varies with the type of virus strain. Among ten distinct strains of Pigeonpea sterility mosaic virus (PPSMV) identified in India, strains from Bengaluru, Dholi, Vamban, and Varanasi were found to be more virulent than those originating from Badnapur, Hyderabad, Pantnagar,

Kanpur, Ludhiana. Faizabad. In addition to direct damage by SMD, powdery mildew infection and spider mite (*Schizotetranychuscajani*) infestation are seen in more aggravated form in SMD infected plants, thus increasing the extent of damage.

Sterility mosaic disease (SMD) is transmitted by an Eriophyid mite, *Aceria cajani* and is not spread through sap, pollen, seed, or soil. These mites are microscopic and measure about 200–250 µm in length, with a short life cycle of about two weeks that includes an egg and two nymphal stages.

These mites are predominantly found on the undersurface of leaves of SMD-infected plants. Their direct feeding does not cause any significant damage to pigeonpea. *Aceria cajani* is highly host-specific, primarily confined to pigeonpea and a few of its wild relatives such as *Hibiscus panduriformis* (yellow hibiscus- Malvaceae family), *Oxalis corniculata* (creeping wood sorrel), and *Canavisa sativa* may act as refuges for mite survival in transit and may, therefore, contribute to the spread of SMD. The main route of mite dispersal is passive, i.e., by wind currents, and the mites can spread up to 2 km from the source. Atmospheric temperature of 20–30°C is very congenial for mite multiplication, while higher temperatures and heavy rains are not favorable. Crops grown under irrigated conditions or in proximity to irrigated fields are particularly vulnerable to early SMD infection due to high relative humidity (80-90%). Diseased plants left in the field after harvest, on the field bank, in the kitchen garden, or wild relatives of pigeonpea such as *Cajanus*, *Platycarpus* and *Cajanus scarabaeoides* serve as reservoirs for the mite vector and the virus during the off-season, thus acting as an inoculum for SMD. In rainfed pigeonpea cultivation, the primary source of inoculum is the stubbles left in the field after harvesting, volunteer plants, or plants near water sources or in the shade as these plants maintain foliage and harbor both the vector mite as well as the virus.

Symptoms of SMD:



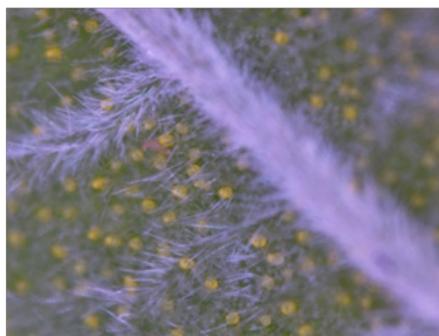
complete sterility



Ring spot



Partial sterility/mild infection



Eriophyid mite under Stereo binocular Microscope

SMD Management

Various strategies have been explored to mitigate SMD incidence including the application of pesticides to delay the onset of infection and disease spread as well as control through cropping methods and host-plant resistance. Proper detection and monitoring of vector mites are crucial for effective control because, usually, the presence of *A. cajani* is determined based on SMD symptoms induced by PPSMV.

Integrated and cultural practices:

1. **Rouging:** Remove and destroy infected plants, especially during the first 40 days after sowing, as this helps reduce the spread of the virus.
2. **Crop rotation:** Rotate with non-host crops to break the disease cycle.
3. **Intercropping:** Intercrop with resistant plants like sorghum or millet, as this can reduce mite populations. (do not intercrop in oil palm as it act as an alternate host for the eriophyid mite)
4. **Debris removal:** Remove and destroy infected plant debris from the field.
5. **Isolation:** Isolate new pigeon pea crops from older, perennial pigeon pea plants, which can harbor the mites.
6. **Chemical control:**
 - a. **Seed treatment:** Treat seeds with imidacloprid 70% WS (5 g/seed) to protect against early infection and
 - b. **Carbofuran 3% CG soil application** was shown to protect the crop from SMD infection by targeting the vector mite for up to 45 days
 - c. **Foliar spraying with Acaricides:** Apply foliar sprays of fenpyroximate 5 EC @ 1 ml/L or Propargite @ 2 ml/L or Fenazaquin 10% EC @ 2.50 ml/l Dicofol @ 5 ml/L/Hexathiazox @ 0.8 ml/L and Wettable sulfur @ 2.5 g/L at 45, 60, 75, 90, and 120 days after sowing (DAS) .
7. Water spray also demonstrated a 70% reduction in the vector mite infestation.
8. Management of SMD through host-plant resistance (HPR) has been prioritized, as it requires no special expertise from growers. HPR is the most reliable and cost-effective approach for SMD management in pigeon pea. The identification of sources of resistance to SMD began with the pigeon pea landrace Sabour 2E in India.

Several pigeon pea varieties resistant to Sterility Mosaic Disease (SMD) have been developed for cultivation in India, including WRG-255 (Warangal Kandi -2), TDRG 59 (also called Telangana Kandi 3), Rajendra Arhar-2, BDN 716, and IPA 15-2 (Sharada). Other varieties like Asha (ICPL 87119) are known for their resistance and are also used in breeding programs to develop new resistant lines.

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