

Original Research Article

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Multi-location Evaluation of Phytohormones and Chemicals for the Management of Pigeonpea Sterility Mosaic Disease (PSMD)

B. R. Sayiprathap^{1,2}, A. K. Patibanda², V. Prasanna Kumari²,
K. Jayalalitha², V. Srinivasa Rao² and Hari Kishan Sudini^{1*}

¹International Crops Research Institute for the Semi-Arid Tropics,
Patancheru, Telangana, India

²Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India

*Corresponding author

ABSTRACT

Sterility mosaic disease (SMD) is the most destructive disease of pigeonpea in the Indian-subcontinent. SMD is caused by *Pigeonpea sterility mosaic virus (PPSMV)* and strain variability coupled with recent discovery of another emaravirus (*PPSMV-II*) made a complex etiology of this difficult to manage viral disease. A field study with phytohormones, chemicals and plant extract was conducted at Bengaluru and Patancheru locations to find out the best treatment for the management of SMD in pigeonpea. Results from the two field trials suggest three sprays of propargite @ 0.15 %, recorded least SMD incidence of 2.00 per cent and effectively control the disease by 93.18 per cent with 80.33 per cent yield increase over control. Similarly, dimethoate @ 0.10 % also showed significant reduction of disease incidence by 92.86 per cent with 79.53 per cent yield increase. Spraying of salicylic acid (SA) @ 0.10 mM and gibberellic acid (GA) @ 250 ppm offered resistance to SMD infection with 40.67 and 42.69 per cent yield increase respectively over the control. However, indole acetic acid (IAA) @ 250 ppm and *Mirabilis jalapa* bulb extract (yellow flower) @ 5.00 % sprays were not effective in the management of SMD.

Keywords

Pigeonpea, Sterility mosaic disease (SMD), Disease management

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Introduction

Sterility mosaic disease (SMD) of pigeonpea also referred to as “Green Plague” is first reported in 1931 from Pusa, Bihar state of India (Mitra, 1931) and subsequently from other states of India. It is considered to be the most destructive disease of pigeonpea in all growing regions causing yield losses up to 205,000 tonnes annually in India (Kannaiyan

et al., 1984). The incidence of SMD varies from year to year and place to place, on susceptible cultivars, early-stage infection (<45-day-old plants) showed characteristic disease symptoms and near-complete cessation of flowering (sterility) and resulted in 95–100% loss in yield (Kannaiyan *et al.*, 1984; Reddy *et al.*, 1995). The SMD is caused by an emaravirus, *Pigeonpea sterility mosaic virus (PPSMV)* (Elbeaino *et al.*, 2015; Kumar

et al., 2000) and transmitted by an eriophyid mite, *Aceria cajani* Channabasavanna (Acari: Arthropoda) (Seth 1962) in a semi-persistent manner (Kulakarni *et al.*, 2002).

Plant virus diseases are managed either through the control of vectors and/or by the application of antiviral compounds. Though several insecticides/ acaricides have been reported to control the vector mite of SMD, they were considered not safe for environment. There is less exploitation of plant hormones like salicylic acid(SA)which induces systemic acquired resistance (SAR)to a wide range of microbial pathogens, including viruses (Delaney *et al.*, 1994) by interfering with three main stages of the plant viral cycle: replication, cell-to-cell movement, and long-distance movement (Aminalah *et al.*, 2011). Green plants are also the source of potential antiviral principles that are effective against a wide range of plant viruses. Extracts of *Mirabilis jalapa*, containing a ribosome-inactivating protein (RIP) *Mirabilis* antiviral protein (MAP), inhibited infection of viruses such as *Tobacco mosaic virus* (TMV), *Cucumber green mottle mosaic virus*, Turnip mosaic, *Cucumber mosaic*, *Potato virus X*, *Potato virus Y*, *Potato leaf roll virus*, and *potato spindle tuber viroid* (Kubo *et al.*,1990; Vivanco *et al.*, 1999).

Recent characterization of a second

Emaravirus, *Pigeonpea sterility mosaic virus-II* (PPSMV-II) (PPSMV referred as PPSMV-I hereafter) associated with SMD of pigeonpea (Elbeaino *et al.*, 2015; Kumar *et al.*, 2017; Patil *et al.*, 2017) made complex etiology of this difficult to manage the viral disease. In this context, the present study was conducted to identify the best treatment in the management of the SMD of pigeonpea.

Materials and Methods

A field experiment was conducted simultaneously at two different locations such as Bengaluru and Patancheru in a randomized block design (RBD) with 3 replications and 7 treatments to find out the best treatment for the management of pigeonpea sterility mosaic disease (SMD) during 2018 rainy season. In both the locations SMD is a major production constraint in pigeonpea. A highly susceptible genotype, ICP-8863 was used for the study. Seven treatments such as three phytohormones, two chemicals, one plant extract and an untreated check were included in the study at both the locations. While imposing treatments, totally three sprays are given, First at 20 days after sowing followed by mite-infested virus inoculation by leaf stapling method. Second and third sprays were conducted on the 40th and 60th day after sowing.

Treatments imposed on pigeonpea for the management of SMD

Treatments	Chemical	Concentration
T ₁	Salicylic acid (SA)	0.10 mM
T ₂	Indole acetic acid (IAA)	250 ppm
T ₃	Gibberllic acid (GA)	250 ppm
T ₄	Proporgite (Omite 57 % EC)	0.15 %
T ₅	Dimethoate (Rogor 30 % EC)	0.10 %
T ₆	<i>Mirabilis jalapa</i> root extract (yellow flower)	5.00 %
T ₇	Untreated check	-

Leaf stapling method of virus inoculation

Leaf stapling method was followed for virus inoculation (Nene and Reddy, 1976). It is the most efficient method for transmission of *Pigeonpea sterility mosaic virus (PPSMV)* onto pigeonpea. In this method, young pigeonpea leaflets from SMD plants infested with eriophyid mites, *Aceria cajani* are stapled onto the primary leaves of the pigeonpea in such a way that the undersurface of the disease leaflet comes in contact with both surfaces of the test plant. Mites from the diseased leaf migrate onto the test seedling and their feeding resulted in virus transmission onto the test plant.

Observations and data analysis

Observations were recorded upon complete flowering on the incidence of SMD and per cent incidence was calculated as per the following formula.

$$\% \text{ SMD incidence} = \frac{\text{Number of SMD infected plants}}{\text{Total number of plants}} \times 100$$

Per cent SMD incidence values of treatments then used to calculate PDI reduction over control using following formula,

$$\text{PDI reduction over control} = \frac{(\text{Control PDI} - \text{Treatment PDI})}{\text{Control PDI}} \times 100$$

The seed yield was obtained from all the treatments separately and the data was further analysed statistically for its significance of difference by the normal statistical procedure adopted for randomized block design and interpretation of data was carried out in accordance with Walter (1997) to know the best treatment in the effective management of sterility mosaic disease

Results and Discussion

Comprehensive analysis of data from the two field trials, conducted at Bengaluru and Patancheru locations for the management of SMD on a susceptible pigeonpea genotype ICP-8863 during rainy season 2018-19 (Figure 1) confirmed that the SMD incidence in untreated control was 97.59 per cent. Three sprays of propargite @ 0.15 %, first at 20 days after sowing followed by second spray at the 40th day and third spray at the 60th day, recorded least SMD incidence of 2.00 per cent and effectively reduced the disease infection by 93.18 per cent with 80.33 per cent yield increase over control. Similarly, three sprays of dimethoate @ 0.10 % effectively reduced the disease by 92.86 per cent with 79.53 per cent yield increase over control treatment.

Three sprays of salicylic acid (SA) @ 0.10 mM, gibberlic acid (GA) @ 250 ppm, offers resistance to SMD infection by 6.37 and 5.88 per cent disease reduction with 40.67 and 42.69 per cent yield increase respectively over the control treatment. But, indole acetic acid (IAA) @ 250 ppm or *Mirabilis jalapa* bulb extract (yellow flower) @ 5.00 % treatment were not effective in the management of the SMD (Table 1 and Figure2).

In the present study spraying of propargite @ 0.15 % and dimethoate @ 0.10 % were showed promising results in the management of pigeonpea SMD and this results were in line with the previous findings of Manjunatha *et al* (2012), Maurya *et al* (2017) and Sudharani *et al* (2017) who reported propargite (0.15 %) effectively controls SMD. Rajeswari *et al* (2016) reported the salicylic acid (SA) @ 200 ppm treatment showed effective management of SMD, however in the present study SA treatment @ 0.10 mM was not showed significant reduction of SMD incidence.

Table.1 Management of sterility mosaic disease (SMD) of pigeonpea during 2018 rainy season

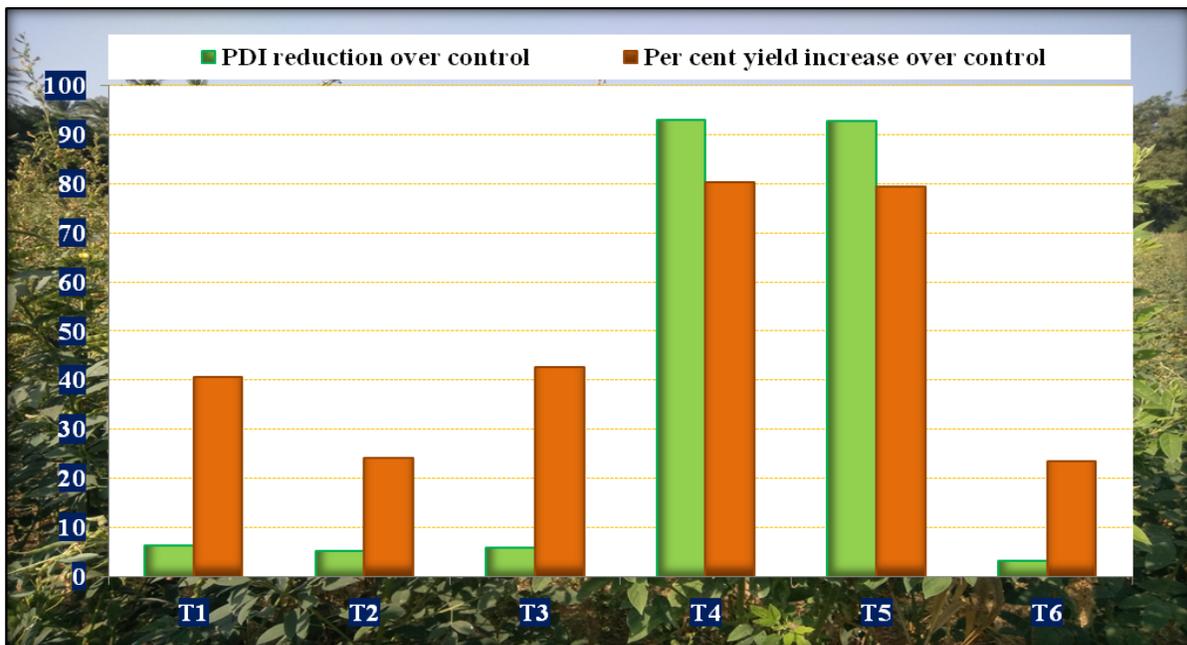
Treatments		PDI at Bengaluru ⁺	PDI at ICRISAT ⁺	Avg. PDI	PDI reduction over control	Yield at Bengaluru (Kg ha ⁻¹) ⁺	Yield at Patancheru (Kg ha ⁻¹) ⁺	Avg. Yield (Kg ha ⁻¹)	Per cent yield increase over control
T ₁	Salicylic acid (SA) @ 0.10 mM	91.50 (73.02)	91.17 (72.69)	91.34 (72.85)	6.40	380.30 ^a	457.64 ^b	418.97 ^b	40.67
T ₂	Indole acetic acid (IAA) @ 250 ppm	93.57 (75.28)	92.00 (73.54)	92.79 (74.39)	4.91	360.80 ^a	295.83 ^a	328.32 ^a	24.29
T ₃	Gibberlic acid (GA) @ 250 ppm	91.90 (73.44)	91.33 (72.85)	91.62 (73.14)	6.11	415.80 ^a	451.68 ^b	433.74 ^b	42.69
T ₄	Proporgite (Omite 57 % EC) @ 0.15 %	2.33 (8.78)	1.67 (7.42)	2.00 (8.13)	97.95	1308.33 ^b	1219.49 ^c	1263.91 ^c	80.33
T ₅	Dimethoate (Rogor 30 % EC) @ 0.10 %	2.67 (9.40)	2.00 (8.13)	2.34 (8.79)	97.60	1257.59 ^b	1171.88 ^c	1214.74 ^c	79.53
T ₆	<i>Mirabilis jalapa</i> root extract (yellow flower) @ 5.00 %	95.20 (77.31)	94.13 (75.95)	94.67 (76.62)	2.99	376.93 ^a	272.36 ^a	324.65 ^a	23.43
T ₇	Untreated check	97.80 (81.44)	97.37 (80.64)	97.59 (81.03)	-	277.56 ^a	219.55 ^a	248.56 ^a	-
C.D. (p≤0.05)		5.85	5.47	5.66		160.89	101.77	131.33	
C.V.		5.87	5.40	5.63		14.45	9.87	12.16	

⁺ Avg. of three replications
values in the paranthesis are arcsin transformed

Fig.1 Typical symptoms of sterility mosaic disease (SMD), yellow mosaic (a), chlorotic ring spots (b), a field experiment of pigeonpea crop for evaluation of chemicals for management of SMD (c), leaf stapling method of virus inoculation on to pigeonpea seedling (inside picture)



Fig.2 Frequency distribution of per cent SMD reduction and yield increase in treatments over the control upon treatment imposition



Insecticides are always the first choice of the farmers for the management of any crop pests/ vectors of plant diseases, because of their quick knockdown effect. Several insecticides/ acaricides such as dicofol (0.25 %), fenazaquin (0.25 %), wettable sulphur (0.3 %), difenthurion (0.1 %), spiromesifen (0.1 %), dicofol (0.2%), abemectin (0.05 %), mitex (0.05 %), have been found effective in controlling the vector mite (*Aceria cajani*) of the SMD (De *et al.*, 1995; Kanadulna *et al.*, 2004; Manjunatha *et al.*, 2017; Maurya *et al.*, 2017; Rajeswari *et al.*, 2016; Sudharani *et al.*, 2017). Phytohormones such as salicylic acid and jasmonic acid, and plant extracts (*Mirabilis jalapa* bulb extract, azadirachtin, neem oil, wintergreen oil, *Vitex negundo* leaf extract, *Psoralea corylifolia* leaf extract) also have been reported to having the positive effect on controlling the plant virus and their vectors (Maurya *et al.*, 2017; Ong and Cruz, 2016; Rajeswari *et al.*, 2016; Sudharani *et al.*, 2017). In the present investigation salicylic acid @ 0.10 mM and gibberlic acid @ 250 ppm treatment offered reasonably good levels of control. So, SA and GA could be included alternative to chemical sprays to reduce the development of resistance by the virus and/or vector to a particular group of chemical. Though chemical management is effective but is not economical so, there is a need for exploitation of economical and environmentally friendly management strategies for any plant disease.

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