International Journal of Plant & Soil Science

Volume 35, Issue 20, Page 1215-1220, 2023; Article no.IJPSS.107119
ISSN: 2320-7035

Performance of Pigeonpea Varieties against Sterility Mosaic Disease (SMD) for Rainfed Regions of Prakasam District, Andhra Pradesh, India

Rajesh Chowdary L. [a++*], Haritha P. [a#] and Pramila Rani B. [a†]

[a] *Agricultural Research Station, Darsi, ANGRAU, India.*

sAuthors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i203919

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:
https://www.sdiarticle5.com/review-history/107119

Original Research Article

Received: 23/07/2023
Accepted: 29/09/2023
Published: 10/10/2023

ABSTRACT

Pigeonpea is one of India's most important grain legumes, accounting for 90 per cent of global production. It is primarily farmed and consumed in poor nations, with India being a major producer. The area under Red gram crop in Prakasam district is about 1,00,000 hectares, which is under Rainfed cultivation during *Kharif* season, as a sole crop. The occurrence of Sterility Mosaic Disease (SMD) has resulted in significant yield loss over the last three years in Prakasam District. As a result, the current study was done to investigate the performance of seven varieties for the disease incidence and yield attributes that are suitable for rainfed region of Prakasam district were evaluated. Among the varieties evaluated, no disease incidence was observed in BSMR 736 (842 kg/ha), ICPL87119 (816 kg/ha) followed by TRG 59 with disease incidence of 8.67 per cent and yield of 756 kg/ha. The variety GRG 152 recorded disease incidence of 4.47 per cent and yield of

[++] *Scientist (Entomology);*
[#] *Research Associate (GPBR);*
[†] *Principal Scientist (Agro.) & Head;*
**Corresponding author: E-mail: l.rajeshchowdary@angrau.ac.in;*

610 kg/ha. The variety LRG 105 recorded disease incidence of 26.33 per cent and yield of 546 kg/ha which was found to be moderately resistant. These findings are important for choosing resistant genotypes and can be used to validate and generate more SMD resistant pigeonpea genotypes in the future.

Keywords: Disease incidence; moderately resistant; pigeonpea; resistant; susceptible; yield.

1. INTRODUCTION

Pigeonpea (*Cajanus cajan* [L.] Millsp) is a multipurpose grain legume crop planted in the semi-arid tropical and subtropical regions of Asia, Africa, and America between 25º N and 30º S. (Van der Maesen, 1990). Pigeonpea is a high protein source that nourishes soil, produces fodder and fuel wood, and helps to prevent soil erosion (Saxena et al., 2002). It is widely consumed in South Asia and is an important source of protein for the Indian subcontinent's people. Redgram is grown on 63.57 lakh hectares worldwide, with a yield of 54.75 lakh tonnes and a productivity of 861.25 kg/ha (FAO, 2021). In 2021-22, India leads the world in redgram output, with 43.4 lakh tonnes grown on 49.8 lakh hectares at an average yield of 871 kg/hectare.

Because of its drought tolerance, pigeonpea is primarily cultivated in the semi-arid states of Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Tamil Nadu, and Uttar Pradesh in India. Pigeonpea is a key crop in the semi arid because of its potential to improve soils, as well as its use as a hardy crop on marginal soils that fits into various intercropping schemes.-tropical aridity. In Kharif 2022, production of red gram was 38.9 (lakh tonnes) in an area of 46.2 (lakh ha). The largest producing states are Maharashtra and Karnataka, with 12.98 and 12.40 lakh hectares, respectively. Andhra Pradesh produced 0.66 lakh tonnes of red gram on 2.52 lakh hectares of land. In terms of red gram productivity, Uttar Pradesh, Maharashtra, and Telangana were determined to be superior. In Andhra Pradesh, Prakasam district has the largest red gram output (0.3 lakh tonnes), whereas Kurnool district has the highest acreage (63,000 acres). The Guntur district has the highest output of red gram (744 kg/ha).

Although India leads the world in both area and production of pigeonpea, its productivity is lower than the global average due to many biotic and abiotic (e.g., drought, salinity, and water-logging) and biotic (e.g., diseases such as Fusarium wilt, sterility mosaic, and insects such as pod borers) factors. Fusarium wilt and sterility mosaic disease (SMD) are the two most serious diseases threatening crop production. Sterility mosaic disease (SMD), also known as the "green plague of pigeonpea," is caused by the pigeonpea sterility mosaic virus (PPSMV) and is transmitted by the eriophyid mite *Aceriacajani*. *Aceriacajani*is one of the key biotic factors causing severe yield losses and hence posing a significant barrier to pigeonpea production on the Indian subcontinent (Kannaiyan et al., 1984). If it occurs at an early stage of crop growth, more than 90% of the crop will be lost (Bhaskaran and Muthiah, 2005). Pigeonpea sterility mosaic virus (PPSMV), an Emaravirus species, is the causative agent of sterility mosaic disease (SMD). This disease, known as the 'green plague' because afflicted plants remain vegetative rather than flowering, has been observed in India and a few other SouthEast Asian nations. SMD is predicted to result in a yield loss of over $300 million per year in India alone [1]. Very few pigeonpea genotypes were identified to have broad-based resistance to SMD, identifying pigeonpea sources with broad-based multiple resistance is critical to increasing pigeonpea output. It has been proposed that wild relatives of farmed plant species have disease and pest resistant genes (Remanandan, 1981). Breeding for resistant cultivars is regarded as one of the most effective and cost-efficient strategies of decreasing crop losses, and it has been given top priority. This is the most cost-effective, affordable, and environmentally responsible option for resource-limited farmers. As a result, the current study sought to assess several pigeonpea genotypes for sterility mosaic disease under rainfed situations.

2. MATERIALS AND METHODS

During Kharif 2022, a field experiment was undertaken at the Agricultural Research Station, Darsi (Prakasam District) of Andhra Pradesh to evaluate the yield response of redgram cultivars in shallow Krishnazone soils under rainfed circumstances.

The experimental site's soil was red sandy loam with a shallow depth, low organic carbon (0.29%), low available nitrogen (85 kg ha-1), medium available phosphorous (28 kg ha-1) and potassium (418 kg ha-1). As an observational study, the experiment was laid up in large size plots.T1: ICPL 87119 (Asha), T2: BMR-736, T3:GRG 152, T4: GRG 811, T5: TS3R, T6: TRG 59, and T7: LRG 105 were the varieties. Working with a tractor drawn disc plough, the trial field was prepared, and then a tractor drawn cultivator was drawn along the field. Healthy redgram seeds with a high germination rate (95%) were utilised for sowing. Sowing began in accordance with the treatments. The seeds were dispersed by dibbling at a depth of 5 cm and were covered and compacted shortly after planting for enhanced germination. Each variety was sowed in a 100m^2 area with 180 x 20 cm spacing. At 15 DAS, thinning was performed by retaining one healthy seedling per hill. The appropriate doses of 20 and 100 kg N and P2O5/ ha, respectively, were treated using urea and single super phosphate. Thinning and gap filling were carried out as needed, and weeding and hoeing were carried out depending on the strength of weeds at critical stages of crop weed competition. Two hand weedings were performed, and all other cultural practises were consistent among treatments. From ten randomly selected plants of each genotype, the incidence of SMD (%), days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of pods per plant, seed yield (Kg/ha), and hundred seed weight (g) were recorded. Data on sterility mosaic disease were collected by counting the total number of plants per unit area and the number of sterility mosaic disease-infected plants in that region using the visual symptoms described by Reddy et al. [2]. Plants that were partially infected as well as totally infected were considered. At the pre-flowering and at harvest the disease incidence was recorded.

$$PDI = \frac{\text{Plants infected with SMD per unit area}}{\text{Total number of plants in unit area}} \times 100$$

The AICRP disease rating scale for sterility mosaic disease on pigeonpea is used, as shown below.

Per cent SMD Incidence	**Reaction**
0-10	Resistant (R)
10.10-30	Moderately Resistant (MR)
>30.10	Susceptible (S)

3. RESULTS AND DISCUSSION

Plant height in different redgram varieties differed significantly at the time of harvest. Maximum plant height was recorded by BSMR 736 (146.40 cm) which was comparable and on par with TRG 59 (143.20 cm) followed by LRG105 (137.20 cm), ICPL87119 (134.40 cm), GRG 811 (126.00 cm), GRG 152 (125.00 cm) and least plant height with 97.50 cm was observed in TS3R variety. The rate of growth in redgram was slower over the first 60 days and then increased rapidly. Seedling growth may be slowed in the early stages of development due to unfavourable drymatterbuild-up. This was followed by a very short exponential phase, and then a lengthier linear development phase in which drymatter increases at a consistent pace for extended durations. As a result, plants tend to take up as much space as possible. Furthermore, the growth points are in the apical meristem, and apical growth tends to produce length, which necessitates an additional supply of growth hormones, as a result of the interaction of various internal growth affecting variables, the majority of which are genetically controlled as reported by Tirumala Rao (2011).

Pigeonpea branching ability is a crucial feature for seed production. Because the number of pods per branch in a single plant is directly tied to the number of branches, the number of branches plays a significant impact in determining pigeonpea production. The number of branches plant per plant ranged from 8.60 to 18.60 in the current study. The BSMR 736 variety had the most branches per plant (18.60), whereas TRG 59 had the fewest (8.6/plant). Sawargaokar et al. (2011) and Niranjan Kumar [3] discovered stable genotypes for this trait as well as fluctuation in the number of branches depending on the environment.

Days to blooming and maturity, as well as grain yield, are significant crop factors to evaluate before releasing a variety. Early blooming, maturity, and grain yield performance of crops ensure a given variety's advantage in the crop production system. The creation of early maturing varieties is crucial not only for pigeon pea crop improvement, but also for climate mitigation as a drought-resistance mechanism in places with marginal rainfall patterns [4].

In the current study, the varieties GRG 152, TS3R, and LRG 105 had the shortest 50% flowering duration (100 days), with days to

Table 1. Performance of redgram varieties against SMD and quantitative traits

Sl. No.	Name of the variety	SMD incidence (%)	Days tofifty per cent flowering	Days to maturity	Plant height (cm)	No. of (Branches/plant)	No. of (Pods/plant)	100 seed weight (g)	Seed yield (kg/ha)
1.	ICPL87119	0.00	130	178	134	15.8	114	11.0	816
2.	BSMR 736	0.00	135	180	146	18.6	116	12.0	842
3.	GRG 152	4.47	100	145	125	11.8	109	9.7	610
4.	GRG 811	0.00	109	151	126	11.0	112	10.0	693
5.	TS3R	42.33	100	146	97	9.8	82	9.8	393
6.	TRG 59	8.67	103	148	143	8.6	102	11.0	756
7.	LRG 105	26.33	100	150	137	9.4	98	10.0	542
	S.Em ±	**1.56**	**0.85**	**1.30**	**0.70**	**0.80**	**2**	**0.06**	**7**
	CD (0.05)	**4.71**	**2.48**	**4.00**	**2.00**	**2.40**	**6**	**0.17**	**21**
	CV(%)	**11.54**	**14.21**	**12.48**	**10.61**	**9.57**	**12.36**	**10.55**	**14.82**

maturity of 145, 146, and 150, respectively. SMD-free cultivars (BSMR 736, ICPL 87119) had days to 50% blooming at 135 and 130 days, with maturity at 180 and 178 days, respectively. The current findings are consistent with the findings of Patel et al. [5] and Vannirajan (2007), who identified genotypes with average responsiveness as well as genotypes with increased environmental sensitivity. Zeru et al. [6] also reported on the results with change in flowering and days to maturity.

The number of pods per plant varied greatly among genotypes, with BSMR736 having the most (116 pods per plant), followed by ICPL87119 (114), GRG 811 (112), GRG 152 (109), TRG 59 (102) and TS3R having the fewest (82 pods per plant). Variability was also noted for days to 50% flowering, days to maturity, number of pods per plant, and number of seeds per pod [7,8]. Such wide variations indicated the scope of improving for these traits. With respect to 100 seed weight among the varieties, BSMR 736 recorded 12.0g followed by ICPL 87119 and TRG 59 with 11.0g. The variety GRG 152 had the lowest 100 seed weight of 9.8g. These findings are consistent with previous reports by Sharma et al. [9], Nagy et al. [10], and Rao et al. [11]. They discovered that genetic variability suggested that genotypes are genetically varied and that variations are caused by the presence of inherent genetic differences between genotypes.

SMD disease incidence was recorded in the varieties tested and among the themthere was no disease incidence was observed in BSMR 736, ICPL87119 and GRG 811varieties and recorded as resistant. Whereas, GRG 152 and TRG 59 recorded 4.47, 8.67 per cent disease of SMD which were also found to be resistant. The variety LRG 105 had a disease incidence of 26.33 percent and was reported to be moderately resistant, while TS3R had a disease incidence of 42.33 percent and was found to be susceptible. This could be due to unfavourable conditions, such as increased rainfall during the pre-flowering and blossoming periods, which harmed the mite vector Aceriacajani. Dipshikha Kaushik et al. [12] found a negative link between mite population and heavy rainfall because it prevents mites from multiplying quickly. Furthermore, Vijaya Bhaskar [13], Roy Abhay Nath, and Kumar Birendra [14] discovered three resistant genotypes and twelve moderately resistant genotypes to sterility mosaic disease against the tick variety.

The variety BSMR 736 had the highest yield of 842 kg/ha, followed by ICPL 87119 (816 kg/ha) and varied statistically. TRG 59, GRG 811, and GRG 152 yielded 756, 693, and 610 kg/ha, respectively. The variety TS3R had the highest disease incidence but the lowest yield (393 kg/ha). Infected plants do not flower and thus do not bear pods, resulting in massive losses for farmers [15-18]. Similarly, Manjunatha et al. (2013) tested pigeonpea genotypes for SMD resistance and discovered seven entries: ICP 7035, BRG 3, ICPL 87091, IPA 8F, IPA 15-F, GT 101, and JKM 189. Pallavi (2014) also observed that five genotypes, ICP 7035, GAUT-001, BAHAR, BRG-3, and IPA 8F, were resistant, eight genotypes were somewhat resistant, and 261 genotypes were susceptible. According to Jaggal et al. (2014), 24 accessions were shown to be resistant to both fusarium wilt and SMD in the field. It was noticed that Pigeon pea varieties have different yield and yield characteristics according their duration in rainfed region [12,19-22].

4. CONCLUSION

Breeding for resistant cultivars is regarded as one of the most effective and cost-efficient strategies of decreasing crop losses, and it has been given top priority. This is the most cost-effective, affordable, and environmentally responsible option for resource-limited farmers.

The findings of the study is important for choosing resistant genotypes and can be used to validate and generate more SMD resistant pigeonpea genotypes in the future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/107119