Evaluation of Roselle (*Hibiscus sabdariffa L.*) Varietal Responses to Foot and Stem Rot caused by *Phytophthora parasitica var. sabdariffae*

Abstract

Mesta or Roselle(*Hibiscus sabdariffa* L.) is one of the most important commercial fibre crops after Cotton and Jute. Foot and stem rot is one of the major devastating diseasesaffectingmesta plants caused by the fungus *Phytophthora parasitica* var. *sabdariffae*.Field trials were conducted at the Agricultural Research Station, Amadalavalasa for two consecutive years during *Kharif* 2022-23 and 2023-24 to evaluate Advanced Varietal Trial (AVT) entries against foot and stem rot in roselle under sick plot conditions.Same Six set of entries were screened under Advanced Varietal Trial (AVT I) during 2022-23 and Advanced Varietal Trial (AVT II) during 2023-24 against foot and stem rot disease of mesta under field (sick plot) conditions. Each treatment replicated thrice in a randomized block design and Analysis of variance (ANOVA) was carried out on the data to test for differences using MS Excel. In AVT I entries, the disease incidence of foot and stem rot ranged from 23.0% (AHS-340) to 42.3% (AHS-342) and the susceptible checks HS 4288 and AMV 5 recorded disease incidence of 46.1% and 47.6% respectively. Among the six AVT II entries screened under sick plot conditions, foot and stem rot incidence ranged from24.1% (AHS-340) to 50.6% (AHS-342). The susceptible checksHS 4288 and AMV 5 recorded disease incidence rates of 50.2% and 60.0% respectively.

Keywords-Roselle,Foot and stem rot, *Phytophthoraparasitica*, Advanced varietal trial.

INTRODUCTION

"Mesta or Roselle (*Hibiscus sabdarifa* L.), is one of the most important commercial fibre crop after Cotton and Jute. In trade and industry both the Jute and Mesta fibre together is known as raw jute. Raw jute/ mestafibre is mainly used in the industry in the manufacture of packaging materials.It is grown in India, Saudi Arabia, Thailand, Malaysia, Vietnam, Philippines, Sudan, Egypt, Mexico and Indonesia" (Mahadevan *et al.* 2009).Mesta, aherbaceous annual plant (lignocellulosic bastfibre crop like jute) believed to be originated from Afro- Asian countries.Mesta is more adaptive and drought tolerant than jute under diverse conditions of climate and soil. Andhra Pradesh is a leading state in the country with respect to both area and production which accounts for 30 per cent of the area and 42 per cent of the production. In A.P., mesta is concentrated in Srikakulam and Vizianagaram districts accounting for 90% area of total

area in the State. Mesta comprises of two major distinct cultivated species — *Hibiscus cannabinus* L. (Kenaf, 2n = 36) and *Hibiscus sabdariffa* L. (Roselle, 2n = 72)(Sarwar, 2023).

"Most of the research on roselle has so far concerned with its antioxidant activity, health benefits, and nutritional value. But the diseases affecting roselle production is not sufficiently investigated" (Hassan *et al.*, 2014; Swathi et al., 2020). The expansion of roselle planting has increased the threat of diseases outbreak.Incidence of different diseases is one of the limiting factors in productivity improvement of this crop. Different diseases of mesta may witness great transformation in the backdrop of climate change with respect to intensity of incidence, development of new strains and susceptibility to the existing methods of control.Some of the common diseases of roselle reported were root rots, foot and stem rot, stem rot, leaf spot and fusarium wilt caused by *Rhizoctoniasolani*, *Sclerotium rolfsii*, *Cercosporahibisci* and *Fusarium oxysporum*respectively."Foot and stem rot is one of the majordevastating disease that affects the mesta plant caused by the fungus *Phytophthora parasitica* var. *sabdariffae*. This disease is prevalent in India, especially in areas such as Andhra Pradesh, Bihar, Odisha and West Bengal. It can cause a loss of 10–25% in fiber yield, and in severe cases, more than 40% of the crop can be lost. The pathogen when attacks the plant kills it totally thus influencing the yield. Cloudy weather from May to September, high rainfall and humidity besides, soil temperature below 30 °C may act as predisposing factor for the outbreak of epiphytotic of foot and stem rot" (De and Mandal 2007b; Islam et al., 2021).

"In this study, more emphasis was made on foot and stem rot disease incited by *Phythophtoraparasitica* var*sabdariffae*which is a soil and water borne pathogen (infection starts when there is water stagnation in the field) and marks significant yield losses (more than 40-50%) under endemic conditions" (De and Mandal, 2007b). "Disease development is favoured by high humidity (70-93%) and temperature range of (24-33^{0}C). Symptoms of the disease include blackening of the stems initiating from collar region which result ultimately in the death of the infected plant" (Ansari *et al.*, 2013).

MATERIAL AND METHODS

Field experiments were conducted at Agricultural Research Station, Amadalavalasaunder sick plot as a rainfed crop for two consecutive years during *Kharif* 2022-23 and 2023-24 to evaluate the six AVT entries (preliminary selection from Initial Varietal Trial) against foot and

stem rot incited by *Phytophthoraparasitica* var. *sabdariffae*in roselle.Different varieties/entireswere sown during June 2022 and June 2023 with a spacing of 30x10cm.The details of the entries are listed below in Table 1.

Each treatment was replicated thrice in a randomized block design. At the time of land preparation, Nitrogen, Phosphorous and Potash were applied at the rate of 30:40:40/ha out of recommended dose of 60:40:40 kg/ha. Balance amount of nitrogen was applied in two equal splits at 30 DAS and 45 DAS. Seeds were sown during June and all the entries were harvested by November. Standard scientific cultivation practices were followed uniformly for all the entries starting from field preparation, sowing, intercultural operations etc. A total rainfall of around 1030 mm has been received during the study period.Maximum and minimum temperature and relative humidity were also recorded and correlated with disease incidence (Fig 1).

Advance varietal trial is constituted by the entries promoted from Initial Varietal Trial (IVT). Limited number of entries in AVT-1 is tested along with a minimum of two checks comprising of national check and local check.Performance of entries in AVT-I will strengthen the promotion of entries to AVT-II and the promoted entries to AVT II were also studied against the incidence of FSR disease.

The observations on disease incidence of foot and stem rot was recorded at 30, 45, 60, 75, 90 DAS and at the time of harvest of the crop. The data of total plant population and number of plants effected by disease have been counted for disease incidence and converted into per cent disease incidence (DI %).

Per cent disease incidence = [(Number of plants infected / total number of plants observed) X 100]

Per cent disease Incidence	**Reaction**
0%	Immune (I)
<1%	Highly Resistant (HR)
1-5%	Moderately Resistant (MR)
6-25%	Moderately Susceptible (MS)
26 & Above	Highly Susceptible (HS)

Chart 1: Observations on disease incidence

Note: Disease rating Scale for Foot and Stem rot incited by *Phytophthoraparasitica* as pertechnical guidelines of lead centre Central Research Institute for Jute &AlliedFibres (CRIJAF).

Analysis of variance (ANOVA) was carried out on the data to test for differences using MS Excel. The significant difference between the varietal means were compared with the least significant differences (LSD) at a 5% level of probability (P=0.05)

Table 1: Entries/Varieties tested in Advanced Varietal Trials used for evaluation during *Kharif* 2022 and 2023.

S. No.	Variety
1.	AHS 338
2.	AHS 340
3.	AMV 5
4.	AHS 334
5.	HS 4288
6.	AHS 342

RESULTS AND DISCUSSION

In the present study, Advanced Varietal Trial (AVT) of diseases tests the reaction of plants to various diseasesand quality traits (yield). As we all know, the pathogenic microorganisms reduce seed germination, plant growth and yield. Pre-disposing factors like micro-climate plays a major role in the disease spread.

Effect of Weather in Disease incidence:

The graphical representation in Fig 1 depicts the recording of weather parameters during the crop growth period/season. The weather parameters such as maximum temperature, minimum temperature etc. were recorded daily during the crop growth period and mean of monthly data were taken into consideration. The maximum average temperature of 36.4°C and 31.6°C were observed during August and November months. Similarly minimum temperature of 19.5°C and 28.6°C were observed during November and October months respectively. The morning and evening relative humidity (RH) ranged from 80-87% with an average of 82.3% during morning hours whereas in the evening, RH was in the range of 57-85% with an average of 77.3%(Fig 1). Theminimum sunshine hours were recorded during the month of

November(3.5hrs/day). As per the correlation studies,there was a significantnegative correlation among maximum temperature, evening relative humidity and sunshine hours per day with the disease incidence of foot and stem rot disease. Rainfall shows significant positive correlation **(0.390**)** with the foot and stem rot disease incidence.Correlation studies reported that gradual increase of disease was observed due to high rainfall and low minimum temperature.

Fig 1. Weather data (pooled) recorded during the crop growing seasons (July-Nov)

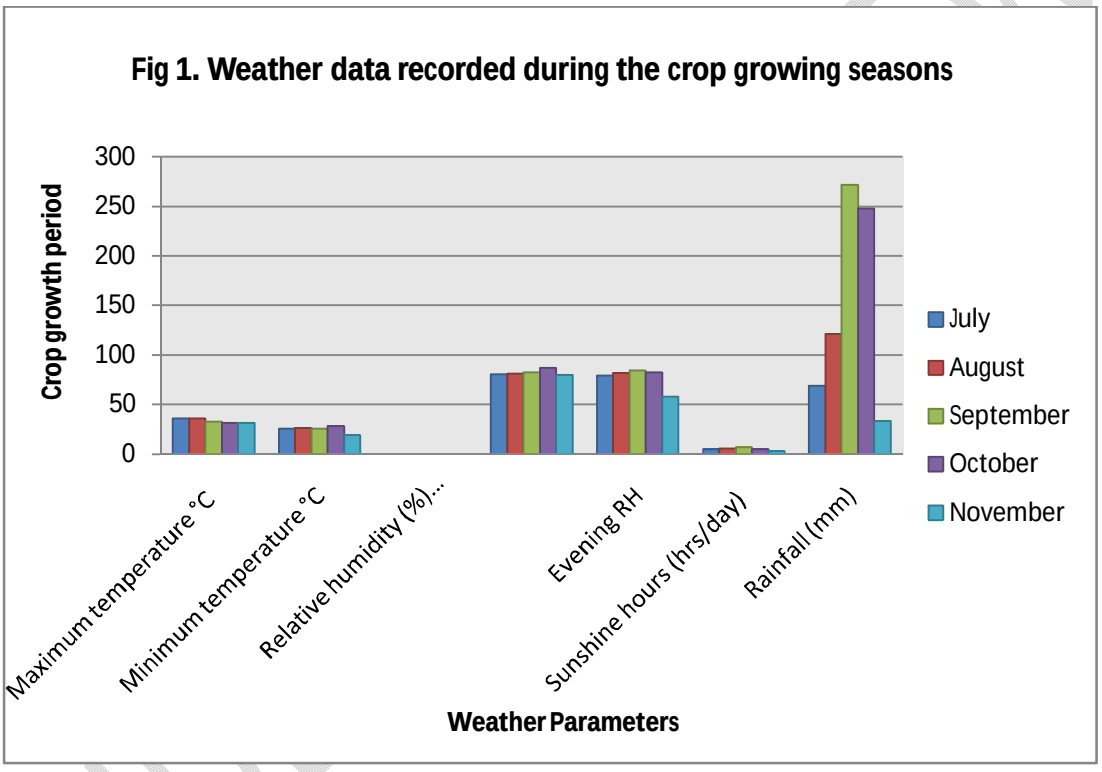

Table 2. Correlation between disease incidence of foot and stem rot of Mesta with weather parametersduring the crop growing seasons

Weather parameters	**Foot and stem rot DI (%)**
Max. temp. (°C)	**-0.46663328***
Min. temp. (°C)	**0.222077151**
Morning R.H. (%)	**0.159012656**
Evening R.H. (%)	**-0.610690268***
Rainfall (mm)	**0.390056149****

***indicates significance at 0.05** indicates significance at 0.01**

Disease incidence in different varieties/entries:

In the present study, under the Advanced varietal trial, among the sixAVT entries screened under sick plot conditions for two consecutive years, foot and stem rot disease was observed in all entries.In AVT I entries, the incidence of foot and stem rot ranged from 23.0% (AHS-340) to 42.3% (AHS-342)at the time of harvest (Table 3).The entry AHS-340 was observed with 23.0% disease incidence and least attack of foot and stem rot disease among all the other entries showing moderately susceptible (MS) reaction followed by AHS-334 (24.5%) with MS reaction. Only these two entries had noticed thelowest incidence of foot and stem rot disease during the *Kharif* 2022 sown crop. Statistically insignificant differences (on par) were observed between thesetwo entrieswhen compared with the other entries and withsusceptible checks. The other entries *viz.,* AHS-338 and AHS-342 were observed with 34.1% and 42.3%, disease incidence respectively, showing highly susceptible reaction.The disease incidence in the susceptible checksHS 4288 and AMV 5were46.1% and 47.6% respectively (Table 3). Statistically significant differences were observed among these treatments when compared tothe control.

Among the six AVT II entries screened under sick plot conditions, foot and stem rot incidence ranged from 24.1% (AHS-340) to 50.6% (AHS-342)at the time of harvest (Table 3). The entry AHS-340 was observed with 24.1% disease incidence and least attack of foot and stem rot disease among all the other entries showing moderately susceptible (MS) reaction followed by AHS-334 (25.5%) with MS reaction. Only these two entries had thelowest incidence of foot and stem rot disease during the *Kharif* 2023 sown crop. The other entries *viz.,* AHS-338 and AHS-342 were observed with 37.9% and 50.6% disease incidence with highly susceptible reactions. The disease incidence in the susceptible checksHS 4288 and AMV 5were50.2% and 60.0% respectively(Table 3). Statistically significant differenceswere observed among these treatments when compared tothe control.Similarly, the pooled mean also represents the same data, the entries AHS 340 and AHS 334 wereobserved with 23.6% and 25.0% foot and stem rot incidence respectively with MS reaction.The susceptible checksAMV 5 and HS 4288 showedstatistically significant differencesfrom best entries*ie.,* AHS 340 and AHS 334(Table 3).

There is significant variation in the susceptibility checks when compared to the disease incidence of best entries.

None of the entries scored less than 5% of the disease incidence to designate it as a resistant line.The average yield loss due to this disease is estimated to be approximately around 10–25%, which increases to more than 40% in severe cases (De and Mandal 2007a). With the wider host range, complete resistance is not available against the foot and stem rot disease ofmesta.The available roselle varieties are more susceptible to Phoma and FSR diseases in experimental fields.None of the roselle cultivars were resistant to these diseases. (De and Mandal 2007a, De and Mandal 2007band Meena and Satpathy, 2018).However, many lines have been identified asmoderately susceptible to this disease.

Yield:

The effect of Foot and stem rot on yield of roselle varieties was also studied and from the pooled mean yield data of AVT I (*Kharif*2022) and AVT II (*Kharif*2023)experiments showedthat, the entries AHS 340, AHS 334, AHS 338 and AHS 342 has shown improved yields of 31.71 q/ha, 30.61q/ha, 32.59 q/haand29.92 q/ha respectively when compared to their susceptible checks AMV 5 (26.26 q/ha) and HS 4288 (27.78 q/ha). All of the above entries showed insignificant differences*i.e.*, there was no statistical variation among the treatments. However, there wasstatistically significant difference among these treatments when compared to thesusceptible checks(AMV 5 and HS 4288).

It is difficult to breed a resistant variety with good yield in the absence of a reliable and stable source. Therefore, germplasm lines showing moderate resistance (moderately susceptiblereactions) will be effective in improving the mesta yields.In the present study, none of the mesta entries was immune or resistant to the disease.As similar study was performed by Sangeetha *et al.*, 2021.They also screened elite entriesin IVT and AVT trials against sesame diseases. In nutshell, two entries, AVT-20-5, AVT-20-1 and in IVT trials IVT-20-17 have shown triple tolerance against root rot, Alternaria leaf spot and phyllody whereas entries AVT-20-6, IVT-20-1, IVT-20-8 and IVT-20-10 showed tolerance against leaf spot and powdery mildew.

Fungal root rot and wilt diseases are among the most urgent obstacles to roselle production as they attack seedlings and mature plants, causing significant yield losses.The variation in disease development mainly depends on the viability of the pathogen whereas all

other congenial environmental conditions in both years remained the same. In the field, the pathogen isfavoured by high temperature and continuous drizzling. The maximum outbreak of this disease occurred when the average monthly rainfall (181–227 mm) was distributed over 16 rainy days and the soil temperature during the period was 27–30 °C (De and Mandal 2007b). Foot and stem rot extensively affect roselle crop from the seedling to harvesting stage. The susceptibility of roselle plants to foot and stem rot increased with age irrespective of variety and the incidence of diseases was higher and lower respectively, according to climatic conditions. (Swathi *et al*., 2020). The June–July month sown crop was more prone to foot and stem rot disease. Infected plant parts and soil debris are more important source of primary inoculum than infection through seed.Therefore, elite lines showing moderate resistance (moderately susceptiblereaction) need to be assessed for their other yield contributing characters, so that they can be further applied in horizontalresistance breeding programmes.

CONCLUSION

Soil-borne root rot and wilt are some of the most severe diseases affecting many crops worldwide, resulting in poor production and quality, and low agricultural income. Such diseases are among the most urgent obstacles to roselle production, as they attack seedlings and mature plants, causing severe yield losses. The identification of disease resistant varieties is a major goal for agricultural scientists and plant breeders. The results of present study described the presence of sufficient genetic variation with respect to fungal diseases within the screened germplasm with a wide range ofinfection per cent.These findings provide a major incentive for breeders to plan a significant breeding program for resistance to diseases.

Table 3: Pooled data of AVT-I (2022) and AVT-II (2023) with roselle (*H.sabdariffa*) for footand stem rot disease and fibre yield.

S. No.	Variety	Disease incidence (%) of Foot and stem rot			Fibre yield (q/ha)			
		2022-23 AVT I	2023-24 AVT II	Pooled mean	2022-23 AVT I	2023-24 AVT II	Pooled mean	
		At harvest			At harvest			Reaction
1.	AHS 338	34.1^{c} (35.6)	37.9^{c} (38.0)	36.0^{c} (36.8)	39.54	25.33	32.59^{a}	HS
2.	AHS 340	23.0^{d}	24.1^{d}	23.6^{d}(29	33.43	29.99	31.71^{ab}	MS

		(28.6)	(29.4)	.0)				
3.	AMV 5	47.6[a](43.6)	60.0[a] (50.8)	53.8[a] (47.2)	26.83	25.69	26.26[d]	HS
4.	AHS 334	24.5[d] (29.6)	25.5[d] (30.2)	25.0[d] (29.9)	33.88	27.34	30.61[abc]	MS
5.	HS 4288	46.1[ab] (42.7)	50.2[b] (45.1)	48.2[b] (43.9)	31.20	24.36	27.78[bcd]	HS
6.	AHS 342	42.3[ab](40.6)	50.6[b] (45.3)	46.5[b] (42.9)	28.35	31.49	29.92[abc]	HS
	SeM +_	1.9	1.1	1.0	1.7	1.3	1.1	
	CD (p=0.05)	5.6	3.2	3.2	5.2	4.0	3.2	
	CV (%)	10.1	5.3	5.5	10.6	9.7	10.2	

Note: the Duncan's multiple range test (DMRT) is a post hoc test to measure specific differences between pairs of means.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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