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# Assessment of promising verities of sorghum for charcoal rot and yield potentiality

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## Abstract
Demonstrations on assessment of promising varities of Sorghum against production potentiality and Charcoal rot disease with farmer participation were conducted in Vijayapur district of Karnataka for two years during 2019-20 and 2020-21. Results indicated that the impact of various varities of Sorghum on days to 50% flowering was ranged from 69.80 to 76.90, on number of percent lodging was ranged from 09.00 to 25. Similarly, the Per cent disease incidence of Charcoal rot was highest in Phule Suchitra plot (5.10) and lowest in CSV-29R (01.00 PDI). Pooled data indicated that, yield was recorded in CSV-29R (12.60 q/ha) which was more than check variety (M35-1) (11.68 q/ha). Improved variety (CSV-29R) recorded higher Gross return of Rs. 32760/ha, net profit of Rs. 28420/ha with benefit cost ratio of 3.00 as against farmer practice (M35-1) wherein, the Gross return of Rs. 30368/ha, net profit of Rs. 19458/ha with B:C ratio was 2.78 for every rupee investment.

**Keywords:** Sorghum, Charcoal rot, production potentiality and economics

## Introduction
Sorghum (*Sorghum bicolor* L. Moench) native to Africa with many cultivated forms now, is an important crop worldwide, used for food (as grain and in sorghum syrup or sorghum molasses), animal fodder, the production of alcoholic beverages, and biofuels. It is the fifth most important cereal crop globally after wheat, maize, rice and barley and India is the fifth largest sorghum producer in the world. Globally, sorghum is cultivated on 41 million hectares to produce 64.20 million tones, with productivity hovering around 1600 kg per hectare (FAOSTAST 2017). Sorghum is one of the major cereal crops of India after rice and wheat. The crop is primarily grown in Maharashtra, Karnataka and Andhra Pradesh. These three states together account for 80 per cent of the all India production. India contributes about 16 per cent of the world's sorghum production. In India, the area under sorghum production is about 5.86 million hectare and total production and average yield being 4.57million tonnes and 0.78 tonne per hectare, respectively (FAOSTAST 2017). In Karnataka, the productivity of sorghum recorded a increasing trend from 950 to 1100 kg per ha from 2008 to 2016. However, during 2017 the productivity reduced from 1154 to 872 kg per ha Compared to 2008, the area under sorghum reduced to 1.39 m ha during 2008 to 0.98 m ha during 2017 with a decrease in production from 1.35 to 0.84 m tones (Anon 2017) [1, 2]. Sorghum is sown in the *kharif* as well as *rabi* seasons. Rabi crop is almost entirely used for human consumption where as *kharif* crop is largely for animal feed, starch, and alcohol industry. Only 5 per cent of the area under sorghum in India is irrigated. Over 48 per cent of the area under sorghum cultivation in the country is in Maharashtra and Karnataka.
Sorghum is the major staple food of millions of rural poor in arid and semi-arid regions of the world. Sorghum is the fifth most important cereal crop and is the dietary staple of more than 500 million people in more than 30 countries. It is grown on 42 million ha in 98 countries in Africa, Asia, Oceania and the Americas. Nigeria, India, USA, Mexico, Sudan, China and Argentina are the major sorghum producers in the world. Grain is mostly used for food (55%), consumed in the form of flat breads and porridges (thick or thin) and is an important feed grain (33%), especially in the Americas. Stover is an important source of dry fodder for dry season maintenance rations for livestock, especially in Asia. The sorghum area in Asia decreased from 23 million ha to 11 million ha between the early 1970s and 2007. Despite the decrease in sorghum area over the years, the production level during 2006 was almost similar to that in early 1970s, which can be largely attributed to the adoption of improved varieties and hybrids.

In 2006–07, India's sorghum was grown on 8.7 million ha (20% of the world's sorghum area), with 3.9 million ha in the rainy season and 4.8 million ha in the post rainy season. In China and Thailand, sorghum is grown on 0.56 and 0.03 million ha, respectively. Productivity in India is 1,345 kg ha-1 in the rainy season and 480 kg ha-1 in the post rainy season. It is the second cheapest source of energy and micronutrients after pearl millet, and majority of population in the central India depends on sorghum for their dietary and energy requirements (Parthasarathy Rao P *et al*. 2006) [11]. Because of its drought adaptation capability, sorghum is a preferred crop in tropical, warmer and semi-arid regions of the world with high temperature and water-stress conditions. In India, the crop is grown in both rainy (June–October) and post-rainy (November–February) seasons. In spite of its multiple uses as food, feed, fodder and bio-fuel, the area under grain sorghum has drastically declined from 18.5 m ha during early 1970s to 5.82 m ha in 2013–14 (ASG 2014). The area under the rainy (kharif) sorghum declined much faster than the winter (*rabi*) due to changing food habits, competition from other commercial crops like cotton and soybean, and poor grain quality due to grain mold disease, etc. Hence there is a need to search for new niches for sorghum cultivation. In recent years, sorghum cultivation in rice-fallows during late-rabi has gained popularity in non-traditional area of Andhra Pradesh due to insufficient water for second crop of rice, and the area under sorghum has increased from 2000 ha in 2005–06 to >21,000 ha, with an average productivity of 6.5 t/ha (Mishra J. S *et al*. 2012) [10]. In eastern India, especially in south Bihar, Jharkhand, Chhattisgarh and parts of Odisha, large area remains fallow after kharif paddy due to non-availability of sufficient water for second crop. In such areas, sorghum has a potential for expansion. With limited irrigation facilities, it can be a potential alternative to summer mung bean, which suffers badly due to infestation of yellow mosaic virus (YMVs). The average productivity of some of the sorghum hybrids, *viz*. 'CSH 16' in rice-fallows is very high (>7.0 t/ha) (Mishra *et al*. 2013) [9]. Being a C4 crop, it utilizes high temperature and solar radiation more efficiently. It can be very well fitted in cropping system with limited irrigation facilities. Under changing climate scenario, sorghum being a drought-hardy crop will play an important role in food, feed and fodder security of the northern Karnataka.

Sorghum is known to be infected by so many diseases. Among them few are economically important and wide spread causing heavy losses *viz*., Charcoal rot, Grain mould, Head smut, Grain smut, Cover smut, Downey mildew and Blight etc. Charcoal-rot of sorghum (*Sorghum bicolor*) caused by *Macrophomina phaseolina* (Tassi) Goid. is endemic to tropical and temperate regions of the world (Wyllie 1998) [14]. Significant losses of yield (up to 64%) have been observed in India under conditions favoring the incidence of the disease in post-rainy sorghum, occupying more than 5 million ha in Maharashtra, Karnataka and Andhra Pradesh (Das *et al*. 2008) [5]. In addition to severely damaging the crop, the pathogen also produces a toxin called "phaseolinone" in the diseased stalk that causes anemia in mice (Bhattacharya G *et al*. 1994) [4]. Management of charcoal rot of sorghum is difficult, as no single control measure is fully effective. The pathogen is very severe especially when an off-season summer crop is taken particularly in black soil. Under favorable condition, disease will infect quickly and cause huge economic losses ranging from 10-100 percent (Smitha K P *et al*. 2015) [12]. The pathogen is primarily a soil inhabitant generally affects the fibro vascular system of the roots which prevents the transport of nutrients and water to the upper parts of the plant. Recently under field condition Charcoal rot was noticed in Sorghum as major proportion in the farmer holdings which has significant effect on plant diversity and yield with current scenario of increasing temperature, due to global warming this disease gaining importance in field (Mihail *et al*. 1995) [8]. Due to its soil inhabitancy the management is very difficult. Hence, the present study was attempted to manage the soil borne disease with host plant resistance sources by screening different varities of Sorghum against *Macrophomina phaseolina*.

## Materials and Methods

Demonstration with different varities of Sorghum was carried out with the farmer participation in *Rabi* Sorghum through Krishi Vigyan Kendra, Vijayapur for two years during 2019-20 and 2020-21 under irrigated situation. Each demonstration was conducted in an area of 0.4 ha and adjacent to the demonstration plot a check plot (farmer practice) of 0.4 ha was maintained for the comparison. The demonstrations were conducted in different villages of Vijayapur district of Karnataka with 20 farmers (in 08 ha land) for a period of two years. Each year prior to the implementation of programme, all selected farmers were trained on Integrated Crop Management in Sorghum in the Krishi Vigyan Kendra and these selected beneficiaries were provided with all the essential inputs. Data on pest and diseases, yield and plant growth parameters were recorded from both the demonstrated and check plot for the comparison. Each year 05 demonstrations covering 2 ha of land under different Sorghum varieties *viz*., CSV-29R, SPV 2217, Phule Revati and for check local verity M35-1 was used. The problems were identified through structured questionnaire. The need based practices were selected in consultation with the farmers, through field experience and also by consulting the agriculture experts in the department. The data on Charcoal rot infected plants of test varities at different stages were recorded when infecting of the local check had occurred. The second stage data on Charcoal rot infected plants were recorded at the initiation of Physiological maturity. The Charcoal rot incidence of each verity was calculated by the following formula:

$$\text{Percent Wilt incidence} = \frac{\text{Number of plants infected}}{\text{Total number of plants examined}} \times 100$$

The level of resistance and susceptibility of each variety was determined by using 1-5 rating scale given by ICRISAT. Charcoal rot scores were measured using 1-5 scale (Table). The genotype that scored '0' were considered immune; those which scored 1 were considered as resistant (R) and damage ranges from 0.1- 116 20%; score 2 were moderately resistant (MR) and in this case damage ranged from 20.1-40%; score 3 i.e. moderately susceptible (MS) was given to those genotypes which showed damage between 40.1-60%; score 4 denoted susceptible (S) genotypes, where damaged ranged from 60.1-80% and score 5 was for highly susceptible (HS) group where damage raged between 80.1-100%.

| Score | Disease incidence (%) | Category |
|---|---|---|
| 0 | 0 | Immune |
| 1 | 0.1-20 | Resistant (R) |
| 2 | 20.1-40 | Moderately Resistant (MR) |
| 3 | 40.1-60 | Moderately Susceptible (MS) |
| 4 | 60.1-80 | Susceptible (S) |
| 5 | 80.1-100 | Highly Susceptible (HS) |

Apart from Charcoal rot observations were also recorded on growth and Yield parameters also on different time interval. The data collected from the farmers regarding production cost, inputs used and monitory returns etc. for working out the economic feasibility of the recommended technology at the experimental station (Eswaraprasad Y *et al*. 1993) [6]. Experiment was planted in a Randomized block design having five replication. Each variety was planted in 45 cm X 15 cm spacing.

## Results and Discussion

### Days to 50% flowering and Percent Lodging

Impact of various varities of Sorghum on days to 50% flowering was recorded (Table 1), among the various varities of Sorghum, variety Revati has early 50% flowering with 69.80 days fallowed by variety SPV 2217 with 75.80 and CSV-29R with 76.50 days to 50% flowering and the variety M35-1 was late to 50% flowering with 76.90 days.

Among the various varities of Sorghum the lowest percent lodging was recorded in variety M 35-1 with 9.0 followed by CSV-29R with 11.60, SPV 2217 with 17.60 and the highest percent lodging was recorded in variety Phule Revati with 25%. The results are in line with the results of Suryavanshi and Mahindre Prakash (1993) [13] and Arun Kumar B *et al.* (2005) [3] who have reported that the adoption of recommended practices in frontline demonstration trials in oilseeds and in hybrid cotton have shown increased yield over respective check plot.

### Charcoal rot disease incidence

The impact of various varities on disease incidence is given in table 1. The percent Charcoal rot disease was ranged from1.0 to 5.10 percent. The charcoal rot disease incidence was severe in variety Phule Revati (5.00 PDI) compared to other varities. However, the lowest charcoal rot incidence was recorded in variety CSV-29R (1.00) followed by M 35-1 (01.80) and SPV 2217 (04.00). The severity of disease in Phule Revati variety may be due to fact that many farmers have a tendency to use pesticides indiscriminately at higher dose, it might have caused disease to outbreak in local variety.

### Sorghum yield and cost economics

Average pooled yield recorded in various varities of Sorghum was ranged from 8.93 to 12.60 q $ha^{-1}$ (Table 1). Among the varities CSV-29R was recorded highest yield of 12.60 q $ha^{-1}$ followed by M 35-1 (11.68 q/ha), Phule Revati (09.08 q/ha) and variety SPV 2217 was recorded lowest yield of 8.93 q/ha. The total mean cost of cultivation was higher in all Sorghum variety demonstrated plots (Rs. 10860/ha). This is due to additional application of vermicompost to the soil at the time of sowing. The comparative profitability of Sorghum crop has been studied by estimating the net profit and benefit cost ratio (Table 2). Highest gross returns, net profit and B: C ratio was recorded in Sorghum variety CSV-29R. CSV-29R recorded higher mean gross return of Rs. 32760 per ha. Mean net profit of Rs. 21850 per ha. with mean benefit cost ratio of 3.00 as against farmer practice (M35-1 variety) wherein, the mean gross return Rs. 30368, the mean net profit was Rs. 19458 per ha with mean B:C ratio was 2.78 for every rupee investment. The lowest mean gross return, Mean net profit and mean benefit cost ratio was recorded in variety SPV 2217 with 23218, 12308 and 2.13 respectively. It can be concluded from the study that increased Sorghum yield was due to the adoption of improved varities. The study further reveals that the fluctuation in yield is the major cause for the fluctuation in the output. Hence, the fluctuation in yield has to be controlled to bring in stability in the output (Kaushik, 1993 and Suryawanshi S D *et al*. 1993) [7, 13].

**Table 1:** Impact of various verities of Sorghum on growth, yield and disease parameters

| Treatments | Days to 50% flowering | | | Percent Lodging | | | Yield (Q/ha) | | | Percent Charcoal rot | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled | 2019-20 | 2020-21 | Pooled |
| T1. M35-1 | 77.60 | 76.20 | 76.90 | 8.40 | 9.60 | 9.00 | 11.28 | 12.08 | 11.68 | 1.60 | 2.00 | 1.80 |
| T2. CSV-29R | 75.60 | 77.40 | 76.50 | 11.20 | 12.00 | 11.60 | 10.00 | 15.20 | 12.60 | 1.20 | 0.80 | 1.00 |
| T3. SPV 2217 | 76.00 | 75.60 | 75.80 | 17.20 | 18.00 | 17.60 | 8.74 | 9.12 | 8.93 | 4.20 | 3.80 | 4.00 |
| T4. Phule Revati | 69.60 | 70.00 | 69.80 | 24.80 | 25.20 | 25.00 | 9.18 | 8.98 | 9.08 | 5.00 | 5.20 | 5.10 |
| SEM | 2.08 | 1.67 | 1.51 | 1.17 | 1.13 | 1.13 | 0.58 | 0.74 | 0.62 | 0.60 | 0.51 | 0.55 |
| CD @0.05 | 6.41 | 5.16 | 4.65 | 3.61 | 3.49 | 3.49 | 1.80 | 2.28 | 1.93 | 2.00 | 1.57 | 1.70 |

**Table 2:** Impact of various verities of Sorghum on cost of cultivation

| Treatments | Gross return (Rs/ha) | | | Gross Cost (Rs/ha) | | | Net Profit (Rs/ha) | | | B:C ratio | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019-20 | 2020-21 | Mean | 2019-20 | 2020-21 | Mean | 2019-20 | 2020-21 | Mean | 2019-20 | 2020-21 | Mean |
| T1. M35-1 | 29328 | 31408 | 30368 | 10720 | 11000 | 10860 | 18608 | 20308 | 19458 | 2.73 | 2.83 | 2.78 |
| T2. CSV-29R | 26000 | 39520 | 32760 | 10720 | 11000 | 10860 | 15280 | 28420 | 21850 | 2.43 | 3.56 | 3.00 |
| T3. SPV 2217 | 22724 | 23712 | 23218 | 10720 | 11000 | 10860 | 12004 | 12612 | 12308 | 2.12 | 2.14 | 2.13 |
| T4. Phule Revati | 23868 | 23348 | 23608 | 10720 | 11000 | 10860 | 13148 | 12248 | 12698 | 2.23 | 2.10 | 2.17 |

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