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Performance Evaluation and Release of High-Yielding Dual-Purpose Rabi Sorghum Culture Tandur Jonna 1' (SVT 68) for Cultivation in Telangana, India

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Authors' contributions

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

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ABSTRACT

Aims: To develop a high yielding dual purpose Rabi sorghum culture suitable for the state of Telangana.
Study of Design: Randomized Block Design.
Place and Duration of Study: The Present study was conducted at Agricultural Research Station, Tandur, Vikarabad from 2007 to 2013 to breed the culture SVT 68 and subsequently evaluated in different trials from 2014 to 2021.
Methodology: A high yielding, dual purpose Rabi sorghum variety was derived from a cross between PV 15 x CSV 216R through Pedigree method of breeding and subsequently it was evaluated instation level from 2014 – 2016, AICRP trial in 2017-18 in, state MLT in 2018-19, Minikits in 2019-2021 for its grain and fodder yields, resistance to pests and diseases and showed superior performance over the Popular check M 35-1.
Results: The high yielding dual purpose Rabi sorghum culture SVT 68 recorded an average grain yield of 2993 kg/ha and fodder yield of 9258 kg/ha with an increase of grain yield of 17.3 per cent and fodder yield of 20.4 per cent, over the popular check M 35-1. The culture is moderately resistant to charcoal rot, shoot fly, tolerant to leaf blight and rust and on par with M 35-1 with respect to stem borer and aphid damage. It has high crude fibre content (2.71) and rich in micro nutrients Iron (41.86 mg/kg), Zinc (26.67 mg/kg) and Calcium (177.60 mg/kg).
Conclusion: Owing to its superiority in terms of grain, fodder yields, pest, disease tolerance, nutritional quality, agronomic performance, higher net returns depicted in the form of Benefit cost ratio, the culture SVT 68 was released during 2021 in the name of Tandur Jonna 1 and notified for general cultivation by farmers in Telangana state.

Keywords: Dual purpose; leaf blight; rust; sorghum bicolor.

1. INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] is one of the important cereal crops cultivated globally for food, feed, fodder, fuel and bioenergy [1-3]. In India sorghum occupies an area of 4.37 million hectare with a production of 4.812 million tonnes. Maharashtra is the major sorghum growing state in India occupying area of 2.078 million hectares with a production of 1.746 million tonnes followed by Karnataka (0.903 million tonnes), Rajasthan (0.589 million tonnes), Tamil Nadu (0.405 million tonnes), Andhra Pradesh (0.411 million tonnes), Uttar Pradesh (0.274 million tonnes) and Madhya Pradesh (217 million tonnes) [4]. In Telangana sorghum occupies an area of 2, 24,017 acre with a total production of 1, 20, 972 tonns [5]. In Telangana major sorghum growing districts are Adilabad, Rangareddy, Mahbubnagar and Sangareddy, Vikarabad, Nagarkurnool, Narayanpet and Kumuram Bheem Asifabad.

It is grown during both in rainy (Kharif) and post-rainy (Rabi) seasons. Sorghum grown in the rainy season is mainly utilized as feed and other industrial uses as the grain is often caught in incessant rain due to which the quality is affected by grain moulds, post rainy (Rabi) sorghum is primarily used as food owing to its good grain quality and also serves as a main source of stover,.Unlike rainy sorghum being dominated with hybrids, rabi sorghum growing areas are

cultivated with varieties especially landrace selections. Much of the area is covered by M 35-1, a landrace selection developed seven and half decades ago (1969), released from Mohol in Maharashtra but still dominates and occupies a wider area of cultivation in farmers fields of Maharashtra, Karnataka and Telangana owing to its good grain and roti quality. It is widely adaptable to rabi situations and has good pest and disease resistance. Post-rainy sorghum research did not receive much emphasis until nineties and the varieties or hybrids bred and released could not match M 35-1 in yield or quality. Some progress has been made recently with the release of varieties for specific soil depths viz., shallow, medium and deep soils. Strategic research is required to develop new varieties for Rabi season to break the yield plateau. Hence, research was initiated at ARS, Tandur to develop higher yielding varieties than M 35-1 with good roti quality, considerable level of tolerance to pests, diseases which are the major constraints limiting yield in rabi situations. Consequently high yielding dual purpose Rabi sorghum culture SVT 68 was identified and was released for the state of Telangana. The availability of latest high yielding cultivars will help in stabilizing the production of grain sorghum in the country [6]

2. MATERIALS AND METHODS

The present investigation was carried out at Agricultural Research Station (ARS), Tandur from *Rabi* 2007 to 2021.The sorghum culture SVT 68 was developed at Agricultural Research Station, Tandur through crossing between the parents PV 15 and CSV 216R followed by pedigree method of selection. The objective was to develop a high yielding dual purpose *rabi* sorghum variety with good grain, roti quality and tolerance/resistance to charcoal rot, shoot fly, stem borer, aphids and shootbug. This culture was developed during the period 2007-2013 and evaluated in station trials, AICRP trials, State Multilocation trial,Agronomic trial and minikits from R*abi* 2014-21.Minikits (OFTs) were conducted in farmers fields in the state covering 8 districts namely Adilabad, Mancherial, Nizamabad, Nalgonda, Mahabubnagar, Nagarkurnool, Vikarabad and Rangareddy. The culture was tested in All india coordinated trials (IVT) during 2017-2018 in the name of SPV 2551 and its performance with respect to grain yield and fodder yields were recorded. Pest reaction with respect to shoot fly, stem borer, aphids, and disease reaction with respect to charcoal rot, leaf blight, rust and downy mildew were assessed through natural infestation at several locations in the country.

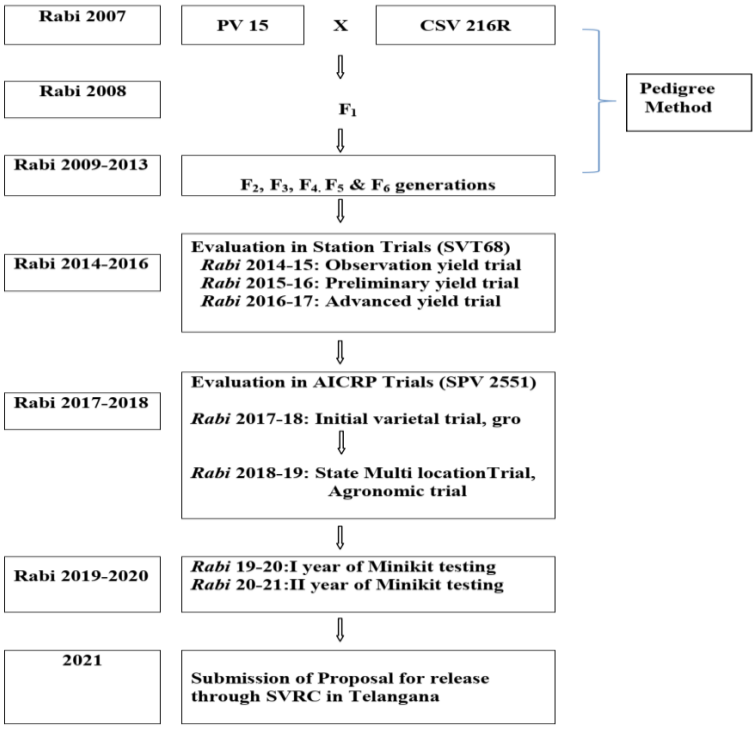

Fig. 1. Flow chart of development of the culture SVT 68 and its evaluation

Table 1. DUS descriptors of the sorghum culture SVT 68

S.No.	Trait &states	SVT 68 score	M 35-1 score
1	Seedling: anthocyanin colouration of coleoptiles (1,2)	Greyed purple (2)	Greyed purple (2)
2	Leaf sheath: anthocyanin colouration (1,2)	Greyed purple (2)	Greyed purple (2)
3	Leaf: midrib colour (1,2,3,4)	White (1)	Yellow green (2)
4	Plant: time of panicle emergence (1,3,5,7,9)	Medium (5)	Medium (5)
5	Plant: natural height of plant up to base of flag leaf (cm) (1,3,5,7,9)	Medium (5)	Medium (5)
6	Flag leaf: yellow colouration of midrib(1,5)	Absent (1)	Absent (1)
7	Lemma: arista formation (1,5)	Present (5)	Present (5)
8	Stigma: anthocyanin coloration (1,5)	Present (5)	Present (5)
9	Stigma: yellow colouration (1,5)	Absent (1)	Absent (1)
10	Stigma: length (mm) (3,5,9)	Medium (5)	Medium (5)
11	Flower with pedicle: length of flower (1,3,5,7,9)	Long (7)	Long (7)
12	Anther: length (mm) (3,5,7)	Medium (5)	Medium (5)
13	Anther: colour of dry anther (1,2,3,4)	Greyed orange (4)	Greyed orange (4)
14	Glume: colour (1,2,3,4,5,6)	Greyed yellow (3)	Greyed Purple (6)
15	Plant: total height (cm) (1,3,5,7,9)	Medium (5)	Medium (5)
16	Stem: diameter (cm) (3,5,7)	Small (3)	Small (3)
17	Leaf: length of blade (cm) (3,5,7,9)	Long (7)	Medium (5)
18	Leaf: width of blade (cm) (3,5,7,9)	Broad (7)	Broad (7)
19	Panicle: length without peduncle (cm) (1,3,5,7,9)	Short (3)	Short (3)
20	Panicle: length of branches (cm) (3,5,7,9)	Medium (5)	Medium (5)
21	Panicle: density at maturity (ear head compactness) (1,3,5,7,9)	Semi compact (7)	Semi compact (7)
22	Panicle: shape (1,2,3,4,5)	Broader in lower part (4)	Broader in lower part (4)
23	Neck of panicle: visible length above sheath (cm) (1,3,5,7,9)	Short (3)	Short (3)
24	Glume: length (1,3,5,7,9)	Medium (5)	Medium (5)
25	Threshability (1,5,7)	Partly threshable (5)	Partly threshable (5)
26	Caryopsis: colour after threshing (1,2,3,4,5)	Yellow white (3)	Yellow white (3)
27	Grain: weight of 1000 grains (g) (1,3,5,7,9)	Medium (5)	Medium (5)
28	Grain: shape in dorsal view (1,2,3)	Circular (3)	Circular (3)
29	Grain: shape in profile view (1,2,3)	Circular (3)	Circular (3)
30	Grain: size of mark of germ (1,3,5,7,9)	Large (7)	Large (7)
31	Grain: texture of endosperm (in longitudinal section) (1,3,5,7,9)	¾ farinaceous (7)	¾ farinaceous (7)
32	Grain: colour of vitreous albumin (1,2,3)	Greyed yellow (1)	Greyed yellow (1)
33	Grain: luster (1,5)	Lustrous (5)	Lustrous (5)

Sorghum supplies important minerals, vitamins, protein, and micronutrients essential for optimal health, growth, and development [7,8]. Assessing the nutritional value of varieties would have a direct impact on the improvement of sorghum for quality breeding and for food product development. The Nutritional constituents, organoleptic quality parameters and roti quality of the culture were estimated at quality control laboratory, Rajendranagar, Hyderabad during 2020-21 using standard protocols. The flow chart depicting its development and evaluation is presented in Fig. 1. The phenology of the culture was shown in Fig. 2. DUS (Distictness,uniformity, stability) descriptors of the culture as per PPVFRA (Protection of Plant varieties and Farmers rights act) were presented in Table 1.

Field view of SVT 68 (SPV 2551)

Panicles Grain

Fig. 2. Field view, panicles and grain of SVT 68

3. RESULTS AND DISCUSSION

3.1 Grain and Fodder Yield Performance

SVT 68 recorded a mean grain yield of 3062 kg/ha and grain yield advantage of 19.2 % over the check M 35-1(2568 kg/ha) in station trials. SVT 68 recorded a mean fodder yield of 7896 kg/ha and fodder yield advantage of 15.8 % over the check M 35-1(6825 kg/ha) in station trials during 2014-17(Table 2)

SVT 68 recorded a mean grain yield of 3243 kg/ha and grain yield advantage of 11.4 % over the check M 35-1(2910 kg/ha) in AICRP trials conducted in 5 locations. SVT 68 recorded a mean fodder yield of 12672 kg/ha and fodder yield advantage of 23.8 % over the check M 35-1(10235 kg/ha) in AICRP trials conducted at 7 locations during 2017-18 (Table 3)

SVT 68 recorded a mean grain yield of 4058 kg/ha and grain yield advantage of 25.9 % over the check M 35-1(3221kg/ha) in State MLT trial. SVT 68 recorded a mean fodder yield of 10115 kg/ha and fodder yield advantage of 21.7 % over the check M 35-1(8310 kg/ha) in State MLT trial conducted during 2018-19 at 3 locations (Table 4)

SVT 68 recorded a mean grain yield of 1213 kg/ha and grain yield advantage of 13 % over the check M 35-1(1074kg/ha) in minikits conducted during 2019-21 at 89 locations in the state (Table 5)

Table 2. Summary of grain yield data of SVT 68 in station trials from Rabi 2014 to 2016

S No	Station Trials	Year	Grain yield (kg/ha)			Fodder yield (kg/ha)		
			SVT 68	M 35-1 ©	Yield advantage	SVT 68	M 35-1 ©	Yield advantage
1	OYT	2014-15	3015	2450	23.0	8075	7296	10.6
2	PYT	2015-16	3148	2600	21.0	7893	6772	16.5
3	AYT	2016-17	3023	2655	13.8	7720	6406	20.5
		Mean	3062	2568	19.2	7896	6825	15.8

Table 3. Performance of SVT 68 (SPV 2551) for grain yield in Initial Varietal Trial during Rabi 2017-18

S. No.	Location	Grain yield (kg/ha)		S.No.	Location	Fodder yield (kg/ha)	
		SVT 68	M 35-1©			SVT 68	M 35-1©
1	Bijapur	2178	1674	1	Tancha	8739	8348
2	Aurangabad	4496	4252	2	Dharwad	7297	6907
3	Karad	2263	2187	3	Gulberga	31944	21759
4	Madhira	3252	3162	4	Aurangabad	14631	12430
5	Tandur	4028	3275	5	Rahuri	7300	6949
	Mean	3243	2910	6	Madhira	9309	6817
	% Yield advantage	-	11.4	7	Tandur	9485	8434
					Mean	12672	10235
					% Yield advantage	-	23.8

Table 4. Pooled data of grain yield and fodder yield of SVT 68 in State multi-location trial during Rabi 2018-19

S.No.	Entry	Parameter	Location			Mean	% Yield advantage
			Madhira	Palem	Tandur		
1	SVT 68	Grain yield	3507	5364	3302	4058	-
2	M35-1 ©	(kg/ha)	4023	3281	2359	3221	25.9
1	SVT 68	Fodder yield	8771	10525	11050	10115	-
2	M35-1 ©	(kg/ha)	8453	6437	10040	8310	21.7

Table 5. Performance of the sorghum culture, SVT 68 in the minikit trials (OFT) during Rabi 2019-21

S.No	Year	Name of the Mandal/District	No. of Minikits	Yield (Kg/ha)		% increase over check
				SVT 68	M 35-1 ©	
1	Rabi	KVK, Palem	10	1032	880	17.2
2	2019-20	DAATTC, Mahabubnagar	9	1083	916	18.2
3		DAATTC, RangaReddy	5	801	730	9.72
4		DAATTC, Nalgonda	5	2034	1748	16.36
5		DAATTC, Nizamabad	10	1312	1175	11.65
6		KVK, Adilabad	10	950	860	10.46
7	Rabi	KVK, Palem	4	923	820	12.56
8	2020-21	DAATTC, Mahabubnagar	4	1813	1688	7.40
9		DAATTC, RangaReddy	17	934	821	13.7
10		KVK, Bellampally	15	1252	1105	13.3
		Total	**89**	**1213**	**1074**	**13.0**

Table 6. Abstract of performance of the sorghum culture, SVT 68 in the trials from Rabi 2014-21

Trial	Season/ Locations	Grain yield(kg/ha)			Fodder yield(kg/ha)		
		SVT 68	M 35-1©	% increase	SVT 68	M 35-1©	% increase
Station trials (2014-2017)	Rabi/1	3062	2568	19.2	7896	6825	15.8
AICRP trials (2017-2018)	Rabi /5,7	3243	2910	11.4	12672	10235	23.8
MLT (2018-2019)	Rabi /3	4058	3221	25.9	10115	8310	21.7
Minikits (2019-2021)	Rabi /89	1213	1074	13.0	-	-	-
Mean		**2894**	**2443**	**17.37**	**10228**	**8457**	**20.4**

Thus pooled data of the trials conducted from 2014-2021 indicates that SVT 68 recorded a mean grain yield of 2894 kg/ha and grain yield advantage of 17.37 % over the check M 35-1(2443 kg/ha). SVT 68 recorded a mean fodder yield of 10228 kg/ha and fodder yield advantage of 20.4 % over the check M 35-1(8457 kg/ha) (Table 6).

3.2 Agronomic Performance

The grain and fodder yields of Rabi Sorghum were significantly influenced by graded levels of fertilizers and different genotypes. Among the fertility levels, 100 % of recommended dose of fertilizer (60 kg N + 40 kg P_2O_5) and 75% RDF (45 kg N + 22.5 kg P_2O_5) significantly recorded on par highest growth and yield. Among the genotypes, significantly highest and on par grain yield was recorded with CSV 29R (2408 kg ha^{-1}) followed by SVT68 (1951kgha^{-1}) over other varieties. Among the five cultivars tested CSV 29R recorded highest grain yield (2408), fodder yield (5257), harvest index (31.45), gross returs/ha (78584), net returns/ha (54484) and Benefit cost ratio (2.26) followed by SVT 68(1951, 5661, 25.42, 68582, 44482, 1.84) respectively. M 35-1 recorded medium values of grain yield (1490), fodder yield (5430), harvest index (20.67), gross returs/ha (56234), net returns/ha (32134) and Benefit cost ratio (1.33) (Table 7).

With respect to dates of sowing Ist and 3rd week of September sowing produced significantly higher grain (2871, 2800 kg/ha) and fodder yields (5882, 6096 kg/ha). Later dates of sowing during October and November showed a declining trend in grain and fodder yield of rabi sorghum. Among the five cultivars tested CSV 29R recorded highest grain yield (2995), fodder yield (5989), harvest index (30.31), gross returs/ha (89851), net returns/ha (67851) and Benefit cost ratio (3.08) followed by SVT 68(2854, 5640, 30.27, 84558, 64558, 3.23) respectively. M 35-1 recorded medium values of grain yield (2362), fodder yield (5594), harvest index (26.05), gross returs/ha (71210), net returns/ha (51210) and Benefit cost ratio (2.56) (Table 8).

3.3 Pest Resistance

3.3.1 Shoot fly

The culture SVT 68 was evaluated during 2017-18 along with M 35-1check for pest reaction to shoot fly, stem borer and aphids at different locations in the country. SVT 68 recorded shoot fly dead heart % of 16.3 at 28 days of emergence as compared to popular check M 35-1 (8.4), (Table 9). Shootfly damage results in the production of extra tillers and yield losses up to 90 % [9]. The seriousness of the shootfly problem in sorghum, combined with high costs and toxicity hazards of using chemical control, renders it necessary to develop new varieties or hybrids that possess resistance to this pest. Also, despite a clear increase in pesticide use in different crops worldwide, crop losses have not significantly decreased during the last 40 years, which emphasizes the need for host plant resistance [10]. As per standard shoot fly scoring system (0-10 % dead heart is scored as Highly resistant), Resistant (11-20% dead heart), Moderately resistant (21-30% dead heart), Susceptible (31-50% dead heart) and Highly susceptible (> 50% dead heart). So the culture SVT 68 (30 %) was considered as resistant to shoot fly while M 35-1 is highly resistant.

Table 7. Evaluation of *Rabi* sorghum genotypes at different fertility levels–Deep soils during Rabi 2018-19 at Agricultural Research Station,Tandur

Treatments	Plant height (cm)	Days to 50 % flowering	Grain Yield (kg/ha)	Fodder Yield (kg/ha)	Harvest Index (%)	Test wt (g)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
A) Factor 1-3 Fertility Levels									
F_1- 50% RDF (30 kg N + 15 kg P_2O_5)	164	69	1581	4733	24.65	3.09	56046	32546	1.39
F_2- 75% RDF (45 kg N + 22.5 kg P_2O_5)	169	71	1902	5801	24.76	3.13	67872	43772	1.82
F_3- 100% RDF (60 kg N + 40 kg P_2O_5)	173	72	2104	6217	25.30	3.26	74349	49649	2.01
SEm+	**2.07**	**0.39**	**130**	**240.3**		**0.09**			
C.D. (p=0.05)	**5.96**	**1.12**	**373.8**	**690.8**		**NS**			
B) Factor 2 -6 Genotypes									
G_1- SPV 2405	184.6	73	1868	5808	24.80	3.68	66996	42896	1.78
G_2- SPV 2348	145.8	72	1948	4749	28.37	2.43	65331	41231	1.71
G_3- CSH 13R ©	176.4	70	1509	6599	18.71	3.62	60808	36708	1.52
G_4- SPV 2551 (SVT-68)	**177.0**	**72**	**1951**	**5661**	**25.42**	**3.49**	**68582**	**44482**	**1.84**
G5- M35-1 ©	178.0	71	1490	5430	20.67	3.22	56234	32134	1.33
G_6- CSV 29R ©	**181.1**	**71**	**2408**	**5257**	**31.45**	**3.43**	**78584**	**54484**	**2.26**
SEm+	**2.93**	**0.55**	**183.9**	**339.8**		**0.12**			
C.D (p=0.05)	**8.43**	**1.58**	**528.6**	**977.0**		**0.35**			
Interaction (A X B)									
SEm+	**5.08**	**0.95**	**318.5**	**588.6**		**0.21**			

Table 8. Growth, yield attributes, yield and economics of sorghum as influenced by Dates of sowing and Genotypes during Rabi 2018-19 at Agricultural Research Station,Tandur

Treatments	Plant height (cm)	DFF	DM	100 seed weight (g)	Grain yield (kg/ha)	Fodder yield (kg/ha)	Harvest index (%)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Dates of sowing										
I week of Sep	192	75	116	3.45	2800	5509	30.48	83111	63011	3.14
III week of Sep	199	71	116	3.45	2871	5882	29.39	85778	65678	3.27
I week of Oct	195	69	115	3.27	2704	6096	27.66	82431	62331	3.10
III week of Oct	171	70	118	3.26	2486	5532	27.52	74231	54131	2.69
I week of Nov	187	68	119	3.32	2101	4827	26.30	62257	42157	2.10
SEm+	**3.1**	**0.4**	**0.5**	**0.2**	**41**	**108**	**0.7**			
C.D. (5%)	**7**	**2**	**1**	**0.8**	**108**	**279**	**1.6**			
Genotypes										
CSV 22 R ©	186	70	116	3.33	2643	5633	28.84	79436	58936	2.87
CSV 29 R ©	179	72	118	3.39	**2995**	**5989**	**30.31**	**89851**	**67851**	**3.08**
Phule Anuradha ©	191	67	118	3.34	2108	4990	25.87	62753	42753	2.14
M35-1©	193	71	120	3.37	2362	5594	26.05	71210	51210	2.56
SPV 2551 (SVT68)	196	72	120	3.46	**2854**	**5640**	**30.27**	**84558**	**64558**	**3.23**
SEm+	**3.1**	**0.4**	**0.5**	**0.2**	**41**	**108**	**0.7**			
C.D. (5%)	**7**	**2**	**1**	**0.8**	**108**	**279**	**1.6**			
C.V. (%)	**5.0**	**3.1**	**1.8**	**5.2**	**2643**	**5633**	**7.7**			

Table 9. Reaction of the SVT 68 to major pests during Rabi 2017-18 (AICRP data)

S. No.	Entry	Shoot fly Dead Heart %	Stem borer Dead Heart %	Aphid score (1-9)	Charcoal Rot Index (CRI)	Rust (1-9 score)	Leaf blight (1-9 score)	Downy mildew (1-9 score)
1	SVT 68	16.3	11.9	5.2	15.27	2.67	3.13	2.33
2	M35-1	8.4	9.9	4.3	17.13	4.27	3.6	2.22
	C.D.(5%)	**4.6**	**4.0**	**1.5**	**3.94**	**1.91**	**1.22**	**0.56**

3.3.2 Stem borer

SVT 68 recorded Stemborer dead heart % of 11.9 at 45 days of emergence compared to popular check M 35-1 (9.9), (Table 9). The spotted stem borer *Chilo partellus* was reported as a serious pest in Indian and African subcontinent. Host plant resistance offers the best option for minimizing losses due to stem borers and considered as the major contributing component in integrated pest management of stem borers in cereals [11]. Thus the culture SVT 68 was considered to be on par with M 35-1 with respect to stem borer reaction considering the CD values at 5% probability.

3.3.3 Sugarcane aphid

Aphid scoring is done on 1 - 9 Scale as follows. 1- no damage to the leaves. 2. 10-20% of leaf area damaged. 3. 20-30 % damage. 4. 30-40%. 5. 40-50%. 6. 50-60% 7. 60-70% 8. 70-80%. 9. > 80% leaf area damaged SVT 68 recorded aphid score of 5.2 compared to popular check M 35-1 (4.3) (Table 9). Aphids are known to infest the sorghum in two ways: direct infestation and indirect infestation. Direct infestation occurs when the aphids feed on the sap of the plant, causing a reduction in the plant's growth and yield. Indirect infestation occurs when the aphids secrete a honeydew substance, which attracts other pests such as ants and flies. These pests feed on the honeydew, and their feeding activity can also damage the plant. Insecticides are costly and, at times, beyond the reach of resource-poor farmers in the semi-arid tropics. The application of chemical insecticides for aphid control under subsistence farming conditions is not economically viable. Therefore, it is important to identify sorghum cultivars that are resistant or less susceptible [12]. Thus the culture SVT 68 was found to be on par with M 35-1 with respect to aphid reaction considering the CD values at 5% probability

3.4 Disease Resistance

3.4.1 Charcoal rot

The culture SVT 68 was evaluated during Rabi 2017-18 along with M 35-1 check for the diseases charcoal rot, leaf blight, rust and downy mildew. A score < 10 % of Charcoal rot index is scored as resistant, 11-25 as moderately resistant and 26-40 as susceptible and > 40 as highly susceptible as per Standard evaluation system. SVT 68 recorded a charcoal rot index % of 15.27 as against the check M35-1 (17.13) (Table 9). Thus the culture SVT 68 is found to be moderately resistant to charcoal rot. Charcoal rot is one of the most important biotic constraints to the production of grain sorghum especially in Rabi ecosystem.The indirect loss due to charcoal rot amounts to 40 % [13]. Employment of newer resistance sources is inevitable for resistance breeding against charcoal rot in sorghum [14]

3.4.2 Other diseases

SVT 68 recorded a leaf blight score of 3.13 when compared to check M 35-1(3.6). The culture recorded a rust score of 2.67 when compared to the check M 35-1(4.27). It recorded a Downy mildew score of 2.33 when compared to the check M 35-1(2.22) (Table 9).Hence for the diseases leaf blight and rust SVT 68 recorded lower levels of damage than the check M 35-1 and it is found to be on par with the check M 35-1 with respect to downy mildew considering the CD value at 5 % probability.

3.5 Nutritional Quality

The culture recorded high crude fibre (2.71 %) when compared to the check M 35-1 (1.75 %) The culture recorded higher ash content (1.54 %) when compared to the check M 35-1 (1.41%). The higher the ash value, the higher is the total mineral content. In the developing countries which have a high population growth rate, availability of mineral nutrient rich food is a critical problem [15]. Iron is a core element in the synthesis of hemoglobin and myoglobin. Its deficiency strongly relates to anemia, mental disorder, immunity problems, children's cognitive ability, poor pregnancy quality, and lower working capacity in adults [16, 17]. Zinc is an essential cofactor of more than 70 enzymes. Its deficiency is ranked in the top five risk factors of disease and death in developing countries [18]. The culture recorded high levels of Iron (41.86 mg/kg), zinc (26.67 mg/kg) and calcium (177.6 mg/kg) respectively when compared to M35-1 (26 mg/kg), (13 mg/kg), (168.47 mg/kg) (Table 10).The culture recorded high overall acceptability of roti (7.8) on par with M 35-1 (8) (Table 11). Compared to post-rainy sorghum predominantly grown for food in India, the rainy season grown commercial hybrids possess 50% higher Fe and Zn concentrations. The popular Rabi sorghum cultivars which are preferred for food use in India like M35-1, Dagdi Solapur, Gidda Maldandi, Parbhani Moti, Parbhani Jyoti, Phule Vasudha, Phule Chitra and Phule

Table 10. Proximate analysis and Micronutrient composition of SVT 68

S. No	Entry	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Crude Fibre (%)	Ash (%)	CH_2O (%)	Iron (mg/kg)	Zinc (mg /kg)	Calcium (mg /kg)
1	SVT 68	10.23	10.37	3.44	**2.71**	1.54	74.42	**41.86**	**26.67**	**177.60**
2	M 35-1	11.16	11.15	3.91	1.75	1.41	72.37	26.01	13.04	168.47

Table 11. Roti quality features of SVT 68 and M 35-1

S.No	Roti quality properties	SVT 68	M 35-1
1	Water required for dough preparation	more (89ml/100g)	medium (78ml/100g flour)
2	Doughing quality	good	good
3	Spreading quality	good	good
4	Colour of roti	creamy white	white
5	Texture	soft	soft
6	Flavour	good	good
7	Taste	good	very good
8	Hedonic score (overall acceptability)	7.8/9	8/9

Anuradha have poor grain Iron and Zinc concentrations [19]. Hence Biofortification is a must to improve the levels of these minerals in rabi sorghum as it goes for human consumption. The culture SVT 68 identified in the present study can help in combating malnutrition.

4. CONCLUSION

In the state of Telangana, Rabi sorghum average productivity does not exceed 6-7 q/acre due to cultivation of M 35-1 and local land races which have good grain and roti quality but low yielding and susceptible to pests & diseases. Hence it is important to develop high yielding varieties and replace the existing local varieties to enhance productivity and farmers net returns. With this background the sorghum culture SVT 68 has been developed. The culture SVT 68 recorded an overall grain yield advantage of 17.3 % and fodder yield advantage of 20 %over the popular check M 35-1. The culture has a grain yield advantage of 250 kg/ha increasing the net returns of the farmer by approximately Rs.10,000-12500/ha depending on the prevailing market price through sale of grain. Additionally the culture has a fodder yield advantage of Rs.500 kg/ha. The culture is moderately resistant to charcoal rot, shoot fly, tolerant to leaf blight and rust and on par with M 35-1 with respect to stem borer and aphid damage. Moreover the entry has more crude fibre in the grain which improves the digestibity and reduces obesity indirectly. It has high concentration of essential minerals and micro nutrients like Iron, zinc, calcium in the grain which help in reducing malnutrition (Hidden hunger). These attributes indicate its superiority and can help in replacement of the popular cultivar M 35-1 and local land races which are predominantly cultivated in the state. Hence cultivating high yielding, dual purpose, sorghum variety SVT 68 shall lead to higher grain yield, fodder yield, quality produce, healthy diet, better market price and higher net returns to the farmers of Telangana.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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 writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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