

## Tirumala (PPR 1012) – A High Yielding Blast Resistant Finger Millet Variety Released for Andhra Pradesh

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### ABSTRACT

*High yielding finger millet varieties are essential to improve productivity levels in rainfed areas of Andhra Pradesh. Tirumala (PPR 1012), a cross derivative of AE 3077 x Ratnagiri is a medium duration (115-120 days) high yielding finger millet variety with a yield potential of 25-30 q/ha released during 2019 through State Varietal Release Committee (SVRC) for commercial cultivation in Andhra Pradesh. Purple pigmentation at nodes, leaf sheath junction and on glumes, and large ear heads with incurved finger tips are the distinguishing features of this variety. Grain is medium bold size and copper brown colour with a test weight of 3.5 g. The variety is resistant to blast diseases viz., leaf blast, neck blast and finger blast. It showed moderate resistant reaction to leaf blight and banded blight. Average grain yield in minikits was 23.85q/ha which was 13.0 per cent higher than standard variety Vakula (21.37 q/ha). It is highly suitable for kharif rainfed situations in Southern Zone of Andhra Pradesh and can be cultivated in all seasons under irrigated situation. The finger millet variety Tirumala (PPR1012) was uniquely identified with DNA fingerprinting.*

**Keywords:** Finger millet variety, Yield trials, Tirumala, Finger printing, Blast.

### INTRODUCTION

Finger millet (*Eleusine coracana* L. Gaertn.) is an allopolyploid with chromosome number  $2n = 4x = 36$  belongs to the family Poaceae (Chennaveeraiah & Hiremath, 1973). Finger millet ranks fourth in importance among millets after sorghum, pearl millet and foxtail millet (Upadhyaya et al., 2007). It is grown over four million hectares and the primary food source for millions of poor people in the dry land regions of east Africa,

Central Africa and southern India (Singh et al., 2008). It is valued for its drought stress tolerance and nutritional value. The great merit of finger millet is that it can be stored for long period of up to ten years or more without deterioration and insect damage. It has traditionally played an important role as “Famine Reserve” crop. It is also being considered to be free of major pests and diseases.

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It is also a good source of mineral nutrients like Calcium, Iron, Phosphorus, Zinc and Potassium. In India, the finger millet area has decreased from 2.5 million ha in late 1980s to 1.02 million ha during 2018 (Directorate of Economics and Statistics, GOI, 2010-11). National average grain yield of finger millet is 1.36 ton/ha, although it has a potential to yield up to 3 t/ha. Low productivity levels are due to lack of varieties suitable for various biotic and abiotic stresses. Finger millet is the major food grain crop grown in Andhra Pradesh after Rice, Jowar and Bajra crops. Andhra Pradesh is the third largest finger millet growing state in India where the crop is grown majorly in North Coastal and Southern zones in 35000 ha with a production of 38000 t/ha and productivity level of 1277 kg/ha. Blast diseases viz. leaf blast, neck blast and finger blast) are major devastating disease in finger millet. (Shailaja Hittalmani et al., 2003). This necessitates to increase the overall productivity level of this crop in the state by enhancing the genetic yield potential of the newly developed finger millet varieties along with blast resistance. The finger millet variety. The present study reports the development of a high yielding blast resistant finger millet variety suitable for rainfed areas of Andhra Pradesh using pedigree breeding approach. Tirumala (PPR1012) was uniquely identified with DNA fingerprinting.

## MATERIALS AND METHODS

### Varietal Development and Field evaluation trials

Development of finger millet breeding populations and field evaluation trials of promising lines were carried out at Agricultural Research Station (ARS), Acharya N.G. Ranga Agricultural University, Perumallapalle, Tirupathi. Biparental cross was attempted between AE 3077 x Ratnagiri and elite single plant selections was made based on plant type, number of tillers, large ear heads and duration from F<sub>2</sub> generation onwards employing pedigree method. Selected single plants were evaluated for their sustained performance and homozygosity up to F<sub>6</sub>

generation. Yield evaluation trials (2010, 2011 and 2012), were conducted with 21-25 days aged seed lings transplanted in well prepared plots (2.25 x 3 m size) at a spacing of 22.5 cm x 10 cm in a randomized block design with three replications. Recommended cultivation practices were followed for raising good crop (include reference). The promising culture PPR 1012 identified from station trials was nominated for multi location trials (2012 and 2013) and all India coordinated trials (2012-14). After testing in the multi-location trials, PPR 1012 line was identified as a high yielding culture, simultaneously screened for its disease reaction to leaf, neck and finger blast diseases. Based on its superior performance over check varieties in the multi-location trials, it was tested in mini kits in farmer's fields for three consecutive years (2014-15, 2015-16 and 2016-17) in 135 locations in eight major finger millet growing districts of Andhra Pradesh.

### DNA Fingerprinting

The newly released variety Tirumala (PPR1012) along with two national check varieties viz., Godavari and GPU67, a state level check variety Vakula and a popular variety, Saptagiri were used for DNA fingerprinting. Genomic DNA was isolated by modified CTAB method (Doyle and Doyle, 1990) from 5 days old finger millet seedlings. The quality of the DNA was checked on 0.8% agarose gels after staining with ethidium bromide and quantified by nanodrop spectrophotometer (Thermoscientific, ND1000). Fourteen RAPD markers were tested (Table 1) for DNA fingerprinting of five finger millet varieties. DNA amplification was performed in 25 µl reaction mixture containing 50 ng genomic DNA, 0.2 µmol/L primers, 10X PCR buffer, 25 mM MgCl<sub>2</sub>, 0.2mM dNTPs and 0.5 units Taq DNA polymerase. All PCR amplifications were performed in a thermal cycler (Eppendorf Vapo. Protect) with the thermal profile of denaturation at 94 °C for 3 min, in 40 cycles 1 min at 94°C (Denaturation), 1 min at 37°C (Primer annealing), 1.5 min at 72°C (primer extension) and final extension at 72°C for 5 min. The

amplicons were separated on 1.5 % Agarose gels in horizontal electrophoresis unit in 1 X TBE buffer at 150 V for 1 hour 30 min. Ethidium bromide was added to the gel at the rate of 3.5 µl/100 ml and the resolved amplicons were visualized under UV transilluminator and photographed with gel documentation unit (Alphainnotech). 100bp DNA ladder (NEB) were used for estimation of allelic size of the amplicons.

## RESULTS AND DISCUSSION

### Field Evaluation Trials

In station yield trials PPR 1012 recorded mean grain yield of 28.95 q/ha where as the check Vakula recorded grain yield of 25.57 q/ha (Table 2). It gave 13.52 per cent increased grain yield over Vakula check. In multilocation trials (2012 & 2013) over three locations of Andhra Pradesh PPR1012 recorded a mean grain yield of 30.10 q/ha with 14.97 % yield increase over check performance (Table 3). In coordinated trial the culture PPR 1012 was tested in different locations of major finger millet growing states of India from 2012-13 to 2014 -15, where in PPR 1012 recorded a overall mean grain yield of 30.74 kg/ha where as the national check GPU 67, gave 28.13 kg/ha (Table 4). In the initial varietal trial (2012-13), PPR 1012 ranked 2<sup>nd</sup> in all the 16 locations of the country and recorded 16.01 % increase in grain yield over long duration check GPU 67. In the first year of advanced varietal trial (2013-14), PPR 1012 stood 1<sup>st</sup> in all 18 locations across India and recorded 8.19 % increase grain yield over long duration check, GPU 67. In second year of advanced varietal trial (2014-15), the mean yield of PPR 1012 stood 2<sup>nd</sup> position in all over India over 15 locations and recorded 4.71 % increase over long duration check GPU 67. PPR 1012 was tested in eight major finger millet growing districts of Andhra Pradesh through adaptive minikit trials in 135 locations. The average grain yield of PPR 1012 in minikits (evaluated in 135 locations in eight districts of Andhra Pradesh from 2014 - 2017) was 23.85 q/ha which was 13.0 per cent higher than Vakula (21.37 q/ha) (Table 5).

PPR 1012 was screened for leaf blast, neck blast and finger blast diseases during 2011-12 and 2012-13 at ARS, Perumallapalle (Table 6). Very low incidence of the blast was recorded in PPR 1012 when compared to the susceptible check Champavati, which indicated the resistance to all the three types of blast. It was also screened for major diseases in co-ordinated trials at different locations during 2012-13, 2013-14 and 2014-15 (Table 7). The reaction towards leaf blast, neck blast, finger blast, leaf blight, banded blight and cercospora leaf spot was considerably low over 8 locations, when compared with tolerant check GPU 67.

Based on its overall performance in the trials the finger millet entry, PPR 1012 was identified as promising culture and released for commercial cultivation in Andhra Pradesh by State Varietal Release Committee (SVRC) in the name of Tirumala during 2019. It is suitable for general cultivation in Southern Zone of Andhra Pradesh. It is highly suitable for *Kharif* rainfed situation and can also be grown in all seasons under irrigated situation.

### DNA fingerprinting of Tirumala (PPR1012)

DNA fingerprinting of finger millet variety PPR1012 and a reference set consisting of two national check varieties (GPU67, Godavari) and state level check varieties (Vakula and Saptagiri) were profiled with 14 RAPD markers. All of these markers amplified successfully and eleven markers (OPB-08, OPC-20, OPC-09, OPF-16, OPF-09, OPN-10, OPN-04, OPN-08, OPR-04, OPS-07, OPT-05) out of 14 RAPD markers are polymorphic in the five varieties of finger millet included in this study. Based on the allelic separation of 14 RAPD markers, the finger millet variety PPR 1012 has distinctly different allelic pattern. The overall size of the amplified product varied from 100 to 1600bp. The DNA fingerprinting can identify finger millet genotypes unambiguously (Figure 1) and facilitate cultivar identification and notification (Bhat, 2006; Amaravathi et al., 2014). A total of 152 alleles were scored in five finger millet genotypes. The genotypic data was converted to binary digit code format

and cluster analysis was based on the average linkage between groups and dendrogram was constructed using software SPSS (ver. 20, IBM software 2009; Norusis, 2004). The

Tirumala (PPR1012) variety was closely clustered with the national check variety GPU 67 (Figure 2). Varieties Saptagiri and Vakula were more related than to Godavari.

**Table 1: List of RAPD markers used in the present study**

S. No.	Marker ID	Primer sequence	Level of polymorphism
1	OPB-08	GTCCACACGG	Polymorphic
2	OPC-20	ACTTCGCCAC	Polymorphic
3	OPC-09	CTCACCGTCC	Polymorphic
4	OPF-16	GGAGTACTGG	Polymorphic
5	OPF-09	CCAAGCTTCC	Polymorphic
6	OPJ-06	TCGTTCCGCA	Monomorphic
7	OPN-10	ACAACCTGGGG	Polymorphic
8	OPN-03	GGTACTCCCC	Monomorphic
9	OPN-04	GACCGACCCA	Polymorphic
10	OPN-08	ACCTCAGCTC	Polymorphic
11	OPR-03	ACACAGAGGG	Monomorphic
12	OPR-04	CCCGTAGCAC	Polymorphic
13	OPS-07	TCCGATGCTG	Polymorphic
14	OPT-05	GGGTTTGCA	Polymorphic

**Table 2: Summary of PPR 1012 grain yield data in station trials at Agricultural research Station, Perumallapalle during 2010 - 2012**

Trial	Year of testing	Grain yield (q/ha)		% increase over Check variety Vakula	C.D (5 %)	CV (%)
		Proposed variety PPR 1012	Check variety Vakula			
Observational yield trial	Kharif, 2010	22.98	19.67	16.8	2.95	8.18
Observational yield trial	Rabi, 2010-11	26.70	23.40	14.1	3.11	13.77
Preliminary yield trial	Kharif, 2011	31.42	28.72	9.40	2.09	16.23
Advanced yield trial	Rabi, 2011-12	34.70	30.49	13.80	1.92	15.52
Mean		28.95	25.57	13.52	-	-

**Table 3: Summary of PPR 1012 grain yield data in Multi-location Trials in research stations of ANGRAU in Andhra Pradesh during 2012-2013**

Location	Year of testing	Grain yield (q/ha)		% increase / decrease over check	CD (5 %)	CV (%)
		Proposed variety PPR 1012	Check variety			
ARS, Vizianagaram	Kharif 2012	29.81	27.57	8.12	3.00	14.05
	Kharif 2013	25.70	23.60	8.89	2.29	12.31
Mean		27.75	25.58	8.50	-	-
ARS, Peddapuram	Kharif 2012	27.80	22.61	22.95	2.14	8.31
	Kharif 2013	22.72	21.00	8.19	1.03	12.06
Mean		25.25	21.80	15.57	-	-
ARS, Perumallapalle	Kharif 2012	26.19	21.58	21.36	3.83	12.05
	Kharif 2013	48.43	40.24	20.35	4.62	8.09
Mean		37.31	30.91	20.85	-	-
Grand Mean		30.10	26.09	14.97	-	-

**Table 4: Summary of grain yield of PPR 1012 (q/ha) in All India Co-ordinated Varietal Trials from 2012-13 to 2014-15**

Year of testing	Name of the Trial	No. of locations	Proposed Variety PPR 1012	Check GPU 67	% increase over the checks
					Check GPU 67
2012 - 2013	IVT	16	29.78 (15.48 - 43.31)	25.67 (9.03 - 35.95)	16.01
2013 - 2014	AVT III	18	30.00 (11.11 - 49.81)	27.74 (12.70 - 39.75)	8.19
2014 - 2015	AVT III	15	32.45 (20.25 - 46.30)	30.99 (17.59 - 46.91)	4.71
Mean			30.74	28.13	9.62

**Table 5: Overall mean performance of PPR 1012 in adaptive minikit trials during 2014-15 to 2016-17 in different districts**

Year	PPR 1012 Grain yield (q/ha)	Vakula Grain yield (q/ha)	% increase over check
Chittoor	20.85	18.90	10.12
Kadapa	18.70	16.38	14.42
Anantapuramu	23.92	20.41	16.81
Prakasam	19.70	17.96	10.63
Mahaboobnagar	31.11	28.14	11.25
Vizianagaram	28.13	25.25	11.66
Vishakapatnam	27.50	24.83	10.81
Srikakulam	20.92	19.13	9.44
Mean	23.85	21.37	11.89

**Table 6: Screening of finger millet entry PPR 1012 in PYT and MLT for blast resistance at Agricultural Research Station, Perumallapalle**

Season	Varieties					
	PPR 1012			Champavathi		
	Leaf blast score	Neck blast (%)	Finger blast (%)	Leaf blast score	Neck blast (%)	Finger blast (%)
Preliminary Yield trials						
Kharif 2011	1.0	0.0	4.3	5	40.0	21.35
Rabi 2011-12	1.0	2.32	13.15	4	69.59	82.57
Multi location trials						
Kharif 2012	2.0	1.64	4.58	3	71.05	61.88
Rabi 2012-13	2.0	1.63	6.20	3	54.90	48.56
Mean	1.50	1.40	7.06	3.75	58.89	53.59

**Table 7: Mean reaction of finger millet entry PPR 1012 to diseases in co-ordinated trials during 2012-2015**

S. No.	Disease name	IVT (2012-13)		AVT III (2013-14)		AVT III (2014-15)		Mean	
		PPR 1012	GPU 67 (C)	PPR 1012	GPU 67 (C)	PPR 1012	GPU 67 (C)	PPR 1012	GPU 67 (C)
1	Leaf blast (G)	1.9	2.4	2.8	3.2	2.5	2.5	2.4	2.7
2	Neck blast (%)	4.6	10.9	7.8	12.6	9.6	15.0	7.3	12.8
3	Finger blast (%)	11.0	16.1	5.7	8.5	11.8	11.4	9.5	12.0
4	Brown spot (G)	0.4	0.0	1.0	1.5	1.0	1.0	0.8	0.8
5	Foot rot (%)	0.9	0.0	10.0	10.4	11.6	12.6	7.5	7.7
6	Banded Blight (%)	0.0	0.0	12.6	20.1	-	-	6.3	10.1
7.	Leaf blight	0.3	1.0	-	-	-	-	0.3	1.0
8.	Cercospora leaf spot (G)	4.0	5.0	-	-	-	-	4.0	5.0

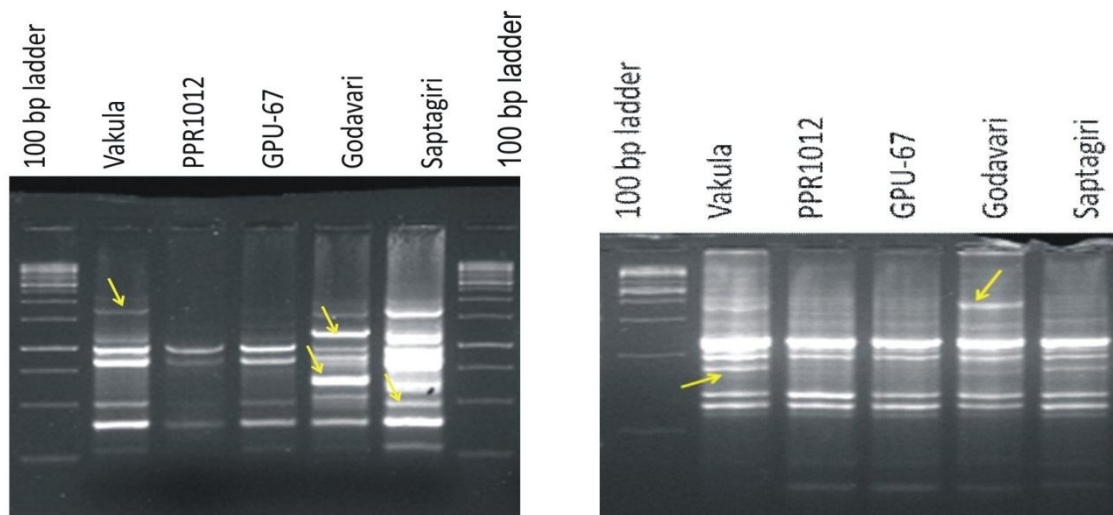


Fig. 1: DNA fingerprint profile of 5 finger millet varieties with marker OPR04 and OPC20

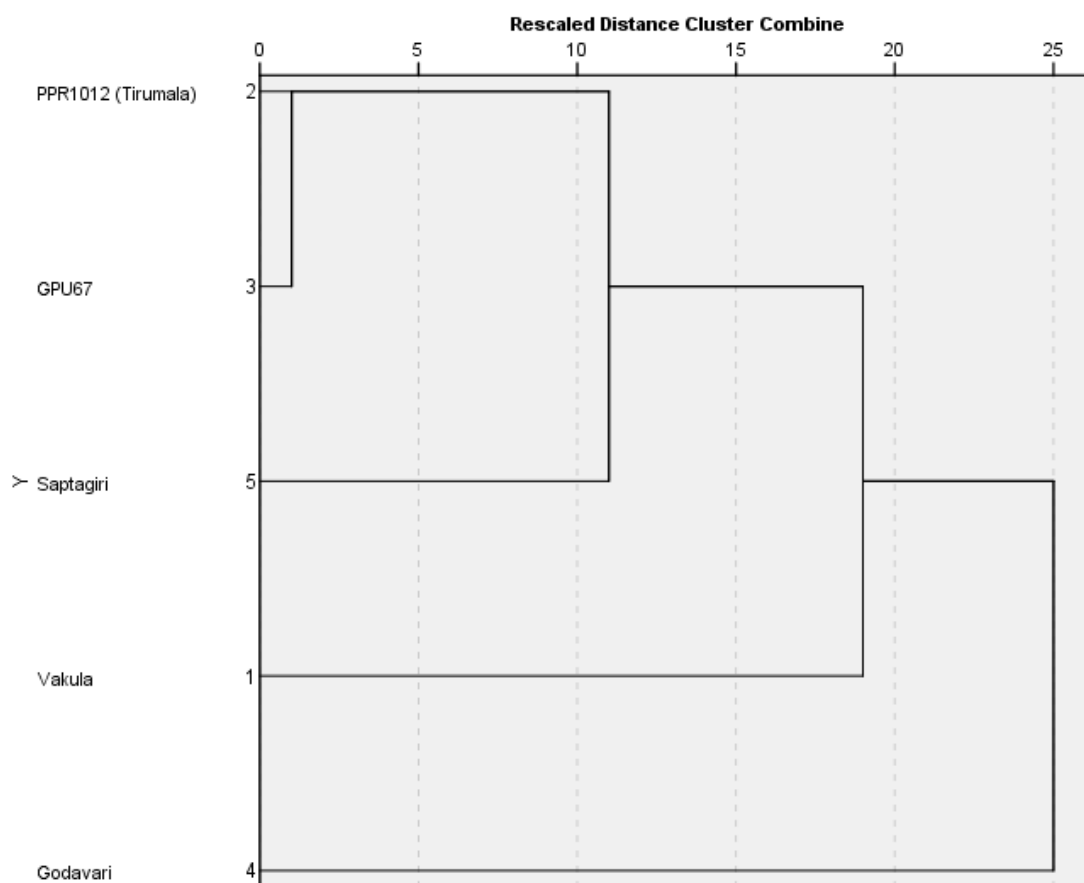


Fig. 2: Dendrogram of Finger millet genotypes based on DNA fingerprint data of 14 RAPD markers using average linkage between the groups constructed with SPSS software

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