



## Vegavathi (VR 929): High yielding and multiple disease resistant finger millet variety suitable for India

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### ABSTRACT

Vegavathi (VR 929) is a fertilizer responsive high grain (3610 kg/ha) and fodder (7190 kg/ha) yielding finger millet variety suitable for growing in India. It is also characterized by its high resistance towards banded blight, brown spot and cercospora leaf spot. Grains are rich in zinc (33 mg/kg) and protein content (9.8%). It was developed by Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Vizianagaram, Andhra Pradesh. The variety was identified and notified by the Central Sub Committee on Crop Standards, India vide notification No. S.O. 3220(E) dated 6<sup>th</sup> September.

**Keywords:** *Banded blight, Breeding, Finger millet, High yield, Multiple disease resistance and Nutri cereal.*

Finger millet, is a climate resilient nutri-cereal which can address tri fold security of food, fodder and nutrition. In Asian and African countries it is mostly grown in resource poor soils for both food and fodder. It can thrive well under harsh climatic conditions where other cereals fail to grow. The charm of the crop lies in its withstanding capacity to drought as well as water logging and salinity to some extent (Gupta *et al.*, 2017, Anuradha *et al.*, 2022).

World wide production of finger millet per annum is 3,834,021 and India is the largest producer of finger millet in the world with a production of 1.2 million tons annually while contribution from all African countries accounts to 2.5 million tons per year (Ceasar *et al.*, 2018).

Banded blight caused by *Rhizoctonia solani* is emerging as a major disease in finger millet. Favourable weather conditions for the disease are 23-30° C temperature along with 80 per cent or above relative humidity. It results in poor grain filling when the infection occurs at early stages on the peduncle and in general the small and shriveled grains are formed resulting severe loss of quality and quantity. PR 202 is the ruling variety in India but is highly susceptible to banded blight and blast disease. Mostly finger millet is grown organically in remote and agency areas of India except Karnataka. Finger millet growing farmers

generally do not adapt any control measures against the disease. Moreover, farmers preference is towards high yielding varieties which are stable in their expression. Identification of stable variety for grain yield is possible with multi environment evaluation (Woyann *et al.*, 2019). The new finger millet culture, VR 929 is a stable high yielding variety with high resistance to banded blight and moderate to blast disease and this variety will be certainly a boon to finger millet growing farmers as well as to consumers since it is rich Zn, protein, Ca and dietary fibre.

### MATERIAL AND METHODS

Finger millet, VR 929 was developed through pedigree method of selection. The cross was made between banded blight disease resistant germplasm, GE 3076 as the female parent and promising breeding line, VR 854 as a male parent during 1999. After confirming the F<sub>1</sub>, superior disease resistant single plant selections were made from F<sub>2</sub> to F<sub>4</sub> during 2001 to 2003. Superior single plant progeny was tested for uniformity in expression from 2004 to 2005 and those superior progeny rows with less disease incidence were forwarded to evaluation trials at Agricultural Research Station, Vizianagaram against check variety, PR 202. Based on its better performance compared to check and other entries tested in the station trials

from 2006 to 2007, it was nominated to Finger Millet Initial Varietal Trial (FM-IVT) of All India Coordinated Small Millets Improvement Project (AICSMP) during 2008. It was tested along with other test entries and the national check variety, PR 202 in Randomized Block Design (RBD) with three replications. The plot size was of 9 m<sup>2</sup> and was experimented under rainfed condition at 13 different locations covering entire India.

VR 929 (3192 kg/ha) recorded a 13.27% increase in grain yield compared to the check, PR 202 (2818 kg/ha) in IVT, and hence was promoted to Advanced Varietal Trial-III (AVT-III). It was evaluated for two years (2009 to 2010) in RBD with three replications and a plot of 9m<sup>2</sup> at 16 locations. PES 110 was included as another check in first year of AVT-III and in the second year of AVT-III, recently released variety, GPU 67 was included. At the time of evaluation of these coordinated trials, DUS traits were not yet developed by the Protection of Plant Varieties and Farmer's Rights Authority (PPV&FRA) and the distinguishing characters of VR 929 were recorded only after the establishment of guidelines for conducting test for distinctiveness, uniformity and stability on finger millet during 2016 (<http://www.plantauthority.gov.in/pdf/Fingermillet.pdf>).

VR 929 and check varieties were screened under field conditions with artificial inoculation of the pathogens for blast and banded blight disease during the three years of AICSMP evaluation trials. Cultures were also naturally screened for other minor diseases like cercospora leaf spot, foot rot and brown spot so as to avoid the release of susceptible cultivar for the benefit of future. Leaf blast and cercospora leaf spot were scored in grades (0-5 scale) while percent disease index was calculated for finger blast, neck blast and banded blight at seven locations during 2008 to 2010. Standard Evaluation System was followed for as per AICSMIP system categorizing the resistant reaction and were categorized as Highly Resistant (HR) =0, Resistant (R) =1, Moderately Resistant (MR) =2, Moderately Susceptible (MS) =3, Susceptible (S) =4 and Highly Susceptible (HS) =5 for leaf blast, cercospora leaf spot and brown spot (Patro *et al.*, 2017). Based on PDI, it was categorized as Highly Resistant (HR) =0.00%, Resistant (R) < 5.00%, Moderately Resistant (MR) = 5.01-10%, Moderately Susceptible (MS) = 10.01-25.00%, Susceptible (S) = 25.01-50.00% and Highly

Susceptible (HS) > 50.00% (Angadi *et al.* 2017). Fertilizer responsiveness of the variety was tested by applying 0, 30, 60 and 90kg N ha<sup>-1</sup> with the recommended dose being 50 kg N ha<sup>-1</sup>. The data on quality parameters were generated during 2011. Moisture, fat, protein and Ca (AOAC, 1999), dietary fiber (Asp *et al.*, 1983), Fe and Zn using dry ashed method (Sahrawat *et al.*, 2002) were analysed at Central Food Technological Research Institute (CFTRI), Mysore, Karnataka.

## RESULTS AND DISCUSSION

### Varietal descriptors

The cultivar VR 929 has an erect growth habit and a medium duration, that means it comes to flowering in 85 days and matures in 120 days (Table 1). The plant is green all throughout nodes and leaf juncture without any anthocyanin pigmentation. Culm branching is absent and at the time of flowering, glumes are dark green in colour and as it matures the fingers become incurved giving the ear head compact shape at dough stage. The fingers of the ear doesn't have any further branching and all the fingers except thumb finger are arranged in a single whorl. At seed maturity, it can be clearly seen that grains are partially covered by the glumes. The shape of the grain is round with smooth seed coat surface and grains are light brown in colour.

### Yield performance

In IVT, the entry, VR 929 (3192 kg/ha) significantly out yielded the check, PR 202 (2818 kg/ha) (Table 2). During 2009-10, in AVT-III first year trial, VR 929 (4074 kg/ha) has exceptionally out yielded the checks, PR 202 (3501 kg/ha) and PES 110 (3481 kg/ha) recording 16.4% and 20.5% improvement over checks, respectively. During final year of testing in AVT-III, VR 929 (3563 kg/ha) recorded higher grain yield compared to check, PR 202 (3347 kg/ha) and recently released check, GPU 67 (3303 kg/ha). The overall average of VR 929 was 3610 kg/ha while that of PR 202 was 3220 kg/ha. VR 929 recorded potential yield of 7037 kg/ha at Peddapuram location of Andhra Pradesh state. Moreover, it performed stably across the country by topping 25 times out of 45 locations tested while check, PR 202 hardly was in top three ranks for 13 times out of 45 locations tested (AICSMIP Annual Report, 2008-2010).

The variety, VR 929 also recorded higher fodder yield (7190 kg ha<sup>-1</sup>) with an increase of 19.17%, 16.09% and 95% over checks, PR 202 (6235 kg ha<sup>-1</sup>), PES 110 (6400 kg ha<sup>-1</sup>) and GPU 67 (3800 kg ha<sup>-1</sup>) (Table 3).

### Fertilizer responsiveness

The entry, VR 929 recorded good response to N-application with increase in 'N' from '0' level to '90' kg N ha<sup>-1</sup>. The recommended dose of fertilizer is 50-40-25. Yield increased from 2885 kgha<sup>-1</sup> to 3186 kgha<sup>-1</sup> from 60 to 90 kg N ha<sup>-1</sup> recording 10.4% increase similar to the check, PR 202 which recorded an increase from 2704 kgha<sup>-1</sup> to 2948 kgha<sup>-1</sup> (9.0% increase).

### Reaction to major diseases

Finger millet test entries were screened under field condition with artificial inoculation. VR 929 showed high resistance to banded blight (3.14%) while check, PR 202 was highly susceptible (86.8%). It is moderately resistant to leaf blast (2 G) and neck blast (8.4%) while check, PR 202 recorded moderate susceptible reaction to leaf blast (3 G) and susceptible reaction to neck blast (46.6%). Another check, GPU 67 (3 G, 12.6%) recorded moderate susceptible reaction to both leaf and neck blast. With respect to finger blast, VR 929 (13.1%) showed very less disease reaction compared to check, PR 202 (20.9%). It recorded high resistance to brownspot (0G) while PR 202 and GPU 67 recorded resistance grade (1G), similarly for cercospora leaf spot, it recorded

resistance grade (1G) like PR 202 while GPU 67 was moderately resistant (2G)

In total, VR 929 was observed to have high resistance to banded blight, brown spot and resistance to cercospora leaf spot while it was moderately resistant to leaf blast and neck blast diseases.

### Quality attributes

Quality characteristics of VR 929 along with other two check varieties, PR 202 and GPU 67 were estimated during 2011 by CFTRI. The variety, VR 929 is very rich in Zn content (33.2mg/kg) recording 199% and 69% increase over checks, PR 202 and GPU 67 (11.1 and 19.6 mg/kg respectively). It is also rich in protein content (9.80 mg/100g) with 21.7 % and 14.4% increase over PR 202 and GPU 67 (8.05 and 8.57 mg/100g, respectively). It even recorded higher Ca and dietary fiber compared to both checks while it recorded lesser tannin content compared to checks.

### Notification and seed production

The variety, Vegavathi (VR 929) was released and notified by central sub-committee on crop standards notification and release of varieties vide notification in the official gazette number. S.O.322(E)-dated 6<sup>th</sup> September, 2019. The ANGRAU, Agricultural Research Station, Vizianagaram, Andhra Pradesh, India is the maintainer of the variety and production of nucleus and breeder seed.

**Table 1. Morphology and DUS characters of VR 929**

Ancillary characters	Description	DUS traits	Description
Days to 50% flowering	80 (80-84)	Growth habit	Erect
Days to maturity	118 (115-120)	Anthocyanin pigmentation	Absent
Plant height (cm)	101 (97-107)	Glume colour	Dark green
1000-grain weight (g)	2.40 (2.36-2.44)	Ear shape	Compact
No. of productive tillers/plant	3 (3-5)	Finger branching	Absent
Ear length (cm)	7.8 (7.5-8.2)	Seed colour	Light brown
No. of fingers/ear	6 (6-7)	Seed shape & Seed covering by glumes	Round shape and partially covered

**Table 2. Grain yield performance of VR 929 in AICSMIP \* yield trials (2008-2010)**

Description	Year of testing	No. of locations	Culture	Standard Check varieties			Other varieties	
			VR 929	PR 202	PES 110	GPU 67	GPU 72	VR 958
Mean yield (kg ha <sup>-1</sup> )	2008-09 (IVT)	13	3192	2818	-	-	2934	2863
	2009-10 (AVT-III)	16	4074	3501	3481	-	3310	3090
	2010-11 (AVT-III)	16	3563	3347	-	3303	2845	2959
<b>Weighted mean</b>		-	<b>3638</b>	<b>3249</b>	<b>3481</b>	<b>3303</b>	<b>3036</b>	<b>2978</b>
% increase/decrease over checks and qualifying entries	2008-09	13	-	13.27	-	-	8.79	11.49
	2009-10	16	-	16.37	20.5	-	23.08	31.84
	2010-11	16	-	6.45	-	7.87	25.24	20.41
	<b>Mean</b>	-	-	<b>11.97</b>	<b>7.6</b>	<b>10.14</b>	<b>19.83</b>	<b>22.16</b>
Yield potential (highest yield harvested) kg ha <sup>-1</sup>			7037	6553	6387	4840	6565	6470
Frequency in top three group			25/45	13/45	Jun-32	Mar-16	Sep-45	Jun-45

\*AICSMIP: All India Coordinated Small Millet Improvement Project

**Table 3. Fodder yield performance of VR 929 in AICSMIP trials (2008-2010)**

Description	Year of testing	No. of locations	VR 929	Check variety			Other varieties	
				PR 202	PES 110	GPU 67	GPU 72	VR 958
Mean yield (kg ha <sup>-1</sup> )	2008-09	12	9060	7740			7200	8130
	2009-10	14	8190	6940	6400		7500	7400
	2010-11	12	4140	3740		3800	4100	4070
<b>Weighted mean</b>			<b>7430</b>	<b>6235</b>	<b>6400</b>	<b>3800</b>	<b>6332</b>	<b>6831</b>
% increase/decrease over checks and qualifying entries	2008-09	12	-	17.05	-	-	25.83	11.44
	2009-10	14	-	18.01	27.97	-	9.2	10.68
	2010-11	12	-	10.7	-	8.95	0.98	1.72
	<b>Mean</b>		-	<b>19.17</b>	<b>16.09</b>	<b>95</b>	<b>17.35</b>	<b>8.77</b>

**Table 4. Reaction of VR 929 to major diseases (mean of three years data)**

Disease name	Culture VR 929	PR 202	GPU 67
Leaf Blast (G)	2.3	2.7	3
Neck Blast (%)	8.4	46.6	12.6
Finger Blast (%)	13.1	20.9	14.4
Banded Blight (%)	3.1	86.8	- <sup>1</sup>
Brown Spot (G)	0.3	0.79	1.1
Cercospora Leaf spot (G)	0	0	2.3

<sup>1</sup>Data not recorded

**Table 5. Quality attributes of VR 929**

Quality Characteristic	VR 929	PR 202	GPU 67	GPU 72	VR 958
Zinc (Zn) (mg/kg)	33.2	11.1	19.6	14.4	12.3
Iron (Fe) (mg/kg)	43.93	42.63	46.87	32.13	37.03
Calcium (Ca) mg/100g)	371	351	361	331	361
Protein (%)	9.8	8.05	8.57	9.5	9.62
Fat (%)	1.53	1.57	1.73	2.04	1.3
Carbohydrate by difference (%)	65.23	66.49	66.83	62.73	66.15
Ash (%)	2.35	2.47	2.45	2.46	2.44
Dietary Fibres (%)	12.59	12.72	12.42	15.94	12.81
Moisture (%)	8.5	8.7	6	6.83	7.68
Tannin content mg Catechin Eq:/100mg dry wt.	0.79	1.01	1.11	1.1	0.59

**LITERATURE CITED**

- Anuradha N, Patro T S S K, Ashok S, Rani Y S, Triveni U, Kumari N, Govanakoppa N, Pathy T and Tonapi V A 2022.** Comparative study of AMMI and BLUP based simultaneous selection for grain yield and stability of finger millet (*Eleusine coracana* (L.) Gaertn.) genotypes. *Frontiers in Plant Science section Plant Breeding*, Doi:10.3389/fpls.2021.786839.
- AOAC 1999.** Official methods of analysis. 16th edn. Association of Official Analytical Chemists, Gaithersburg, USA
- Angadi C, Rao A M, Ramesh S, Ravishankar P, Nagaraja A and Patro T S S K 2017.** Identification of Blast Disease Resistant Finger Millet [*Eleusine coracana* (L.) Gaertn] RILs Screened Under Natural Hot Spot. *International Journal of Current Microbiology and Applied Science* 6(12): 847-857.
- Asp N G, Johansson C G, Hallmer H and Siljestroem M 1983.** Rapid enzymatic assay of insoluble and soluble dietary fibers. *Journal of Agricultural and Food Chemistry* 31(3):476-482.
- Cesar A S, Maharajan T, Krishna T P A, Ramakrishnan M, Roch G R, Satish L and Ignacimuthu S 2018.** Finger millet [*Eleusine coracana* (L.) Gaertn.] improvement: current status and future interventions of whole genome sequence. *Frontiers in plant science* 9: 1054.
- <http://www.plantauthority.gov.in/pdf/Fingermillet.pdf>
- Gupta S M, Arora S, Mirza N, Pande A, Lata C, Puranik S, Kumar S and Kumar A 2017.** Finger millet: a “certain” crop for an “uncertain” future and a solution to food insecurity and hidden hunger under stressful environments. *Frontiers in plant science* 8: 643.
- ICAR-Project Coordinating Unit 2009.** Progress report of all India coordinated research project on small millets improvement project 2008-09, crop improvement. ICAR, GKVK, Bengaluru, BR 28-36.
- ICAR-Project Coordinating Unit 2009.** Progress report of all India coordinated research project on small millets improvement project 2008-09, crop improvement. ICAR, GKVK, Bengaluru, PP 19-20.
- ICAR-Project Coordinating Unit 2010.** Progress report of all India coordinated research project on small millets improvement project 2009-10, ICAR, GKVK, Bengaluru, BR 29-37.
- ICAR-Project Coordinating Unit 2010.** Progress report of all India coordinated research project on small millets improvement project 2009-10, ICAR, GKVK, Bengaluru, PP 25.
- ICAR-Project Coordinating Unit 2011.** Progress report of all India coordinated research project on small millets improvement project 2010-11, ICAR, GKVK, Bengaluru, BR 28-36.

- ICAR-Project Coordinating Unit 2011.** Progress report of all India coordinated research project on small millets improvement project 2010-11, ICAR, GKVK, Bengaluru, PP 26.
- ICAR-Project Coordinating Unit 2012.** Progress report of all India coordinated research project on small millets improvement project 2011-12, ICAR, GKVK, Bengaluru, PAV 18-19.
- Patro T S S K, Divya M, Rani Y S, Triveni U and Anuradha N 2017.** Detection of resistant sources for major diseases in finger millet (*Eleusine coracana* (L.) Gaertn). *Frontiers in Crop Improvement*, 5: 43-47.  
<http://www.plantauthority.gov.in/pdf/Fingermillet.pdf>
- Sahrawat K L, Kumar G R and Rao J K 2002.** Evaluation of triacid and dry ashing procedures for determining potassium, calcium, magnesium, iron, zinc, manganese, and copper in plant materials. *Communications in Soil Science and Plant Analysis* 33: 95-102.
- Woyann L G, Zdziarski A D, Baretta D, Meira D, Dallacorte L V and Benin G (2019).** Selection of high-yielding, adapted and stable wheat lines in preliminary trials. *Crop Breeding and Applied Biotechnology* 19: 412-9.