

GUJARAT ANAND RICE 14: A HIGH YIELDING, MEDIUM SLENDER WITH STRONG AROMATIC VARIETY

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ABSTRACT

IET 24619 is notified with popular name "Gujarat Anand Rice 14" by CVRC, New Delhi for commercial cultivation under irrigated transplanted ecosystem. To breed a superior, medium slender variety of rice with better qualities, research was started since from 2002 than evaluated in state as well as national trials viz., SSVT,LSVT, ASG, AVT I ASG and AVT II ASG during 2009-16 at MRRS, AAU, Nawagam with different centers of AICRIP of India. Results showed the supremacy of IET 24619 with grain yield recorded 5108 kg/ha, which is 31.68, 46.36 and 46.78 per cent higher over the national check viz., Shobini (3879 kg/ha); regional check viz. Sugandhdhan 907 (3490 kg/ha) and local check viz., Krishna Kamod (3480 kg/ha), respectively. IET-24619 found mid-early in maturity (137 to 140 days), medium tall (110 cm height), higher number of panicles/m² (270.33), number of productive tillers (7.5), test weight (16 g) and length of panicles (26.6cm). The grain quality traits viz., head rice recovery (64.9%), amylose content (23.43%), gel consistency (45 mm), strong aromatic grains having with medium slender milled grains 5.66 mm and with volume expansion ratio 4.7. It was moderately resistance to all rice diseases and tolerant to insects and pests.

INTRODUCTION

In India, rice is grown in 43.77 million hectares with 112.76 million tonnes production accounting for productivity of 2576 kg. whereas in Gujarat it grown on 0.80 million hectares with production of 1.75 million tonnes and productivity of 2180 kg/ha during 2017-18 (Anonymous, 2019). Within the country, rice occupies one-quarter of the total cropped area, contributes about 40 to 43 % of total food grain production and plays a key role in the national food and livelihood security. However, productivity of milled rice is low as against the global average productivity of 3.07 tha⁻¹ (Anonymous, 2012). The goal of aromatic rice breeding programme is the combination of several improved traits to produce a cultivar that meets demands of farmer and consumer. There is an increasing demand for the production of high-grain-quality aromatic rice to meet the domestic demand and for export. This rice is long and medium have been popular in the country and are now becoming more popular in Middle East, Europe and in the United States. Most of the trade in aromatic rice is from India, Pakistan and Thailand. Aromatic rice constitutes a small but special group of rice which are considered best in quality. The Basmati rice of the Indian sub-continent clinches a premium and gets three-time higher price than high quality non-basmati types (Singh *et al.* (2000). Most of the consumers prefer fine rice varieties with good cooking quality that have aroma. Due to special flavour and taste, aromatic rice is highly favoured. India produces several fine aromatic rice varieties with excellent eating quality for regular consumption was much preferred by Indian people also like Pusa/Punjab Basmati, but price of scented rice was more due to less productivity and

late maturity, ultimately cost of production was much higher than non-scented varieties. Basmati rice has a harmonious combination of defined kernel dimensions, appealing aroma, fluffy texture of cooked rice, high volume expansion during cooking, linear kernel elongation with minimum breadth-wise swelling, palatability, easy digestibility and longer shelf-life (Singh *et al.* (1988). In Gujarat, the traditional cultivars like Pankhali 203, Krishna Kamod are popular but have a lots of weaknesses viz., tallness, prone to lodging, late in maturity and susceptibility to pest and diseases. The the current need of farmer is a variety which is having a high yield, medium height, medium late, medium slender, inbuilt resistance to pests and disease ; secondly consumers preference is like kernel dimensions, appealing aroma, fluffy texture of cooked rice, high volume expansion during cooking and linear kernel elongation with minimum breadth-wise and third qualities for trader's needs are high head rice recovery, percentage of hulling and milling of rice variety. The paper deals with validation of Gujrat Anand rice 14.

MATERIALS AND METHODS

The present investigation was carried out at the farm of Main Rice Research Station, Anand Agricultural University, Nawagam. During *Kharif* 2002, a cross involving advanced breeding lines, GR 7 (GR 3 X Basmati 370) and Mahisugandha/2-1 (BK 79 X Basmati 370), the details of parentage with pedigree are shown in Fig.1. A large number of single plant selections were made from F₂ population and was bulked it's in F₇ generation during *Kharif* 2009 after stabilize genes and derived as NWGR 7011 and evaluated in preliminary

evaluation trial and small scale varietal evaluation trial comprising 27 genotypes and 10 genotypes along with checks, respectively (Anonymous, 2009). The large scale varietal trials conducted comprising 14, 12 and 12 genotypes during 2012, 2013 and 2014, respectively at different locations of Gujarat (Anonymous, 2011, 2012, 2013). During 2014, it was promoted in IVT ASG trial designated by IET 24619 at national level in coordinated varietal trials of AICRIP comprising 64 promising genotypes of rice along with different national, regional and local checks at different centers of AICRIP in India, sub sequentially promoted in AVT I ASG and AVT II ASG trials of western and other zone of India, during *Kharif* season of 2015 and 2016, respectively (Anonymous, 2018 a).

The experimental breeding materials were selected at the age of 21-25 days of seedlings having 3-4 leave stage and transplanted manually during *Kharif* season using 2 seedlings per hill at spacing of 20 cm. x 15 cm. of seedlings in the well puddle field in Randomized Block Design with three replications along with different national, regional and local checks in every experiment. The cultural practices were followed to maintain a good plant stand and crop cares were undertaken according to the methods of Sanjeev Singh *et al.* (2018). The quantitative characteristics *i.e.* days to 50 % flowering, maturity days (seed - to - seed), plant height (cm), number of panicles/m², 1000-grain wt.(g), grain length and breadth (mm), kernel length/breadth (mm), LB ratio, grain yield (kg/plot). The quality characters *viz.*, head rice, hulling %, milling %, amylose content, alkali spreading value and gel consistency were studied. The head rice (HR) recovery was also determined according to the methods of Khush *et al.* (1979). Amylose content analysis of rice flour of different cultivars was determined auto analyzer and manual modified method of Juliano (1971). The gel consistency test was performed following the method of (Cagampang *et al.* (1973). Consumer mainly prefers rice with soft to medium gel consistency (Tang *et al.* (1991). Alkali spreading value (ASV) of whole kernel (milled rice) measures the gel type of rice. Gelatinization Temperature classification of rice varieties is done using the alkali spreading value (ASV) which is visually determined by a trained laboratory technician after the 23-h alkali spreading test. ASVs of 1-2, 3, 4-5 and 6-7 correspond to high, high-intermediate, intermediate and low GT types, respectively (Little *et al.* (1958). The estimation of the gelatinization temperature and is partly associated with the amylose content of the starch. Alkali spreading value is indirectly correlates with the gelatinization temperature. The reaction against major pests and disease were taken up. Keeping in view the above perspectives, the specific objectives are the grain parameters aiming to improve quality of rice without compromising the yield. The data pertaining to various quantitative characters were analyzed as per the procedure of randomized block design given by Panse and Sukhatme (1978) for individual environments.

RESULTS AND DISCUSSION

The experimental results, of IVT ASG trial of western region (Zone VI) revealed that the average yield of Gujarat Anand Rice 14 (IET 24619) during *Kharif* 2014 is 6022 kg/ha of two

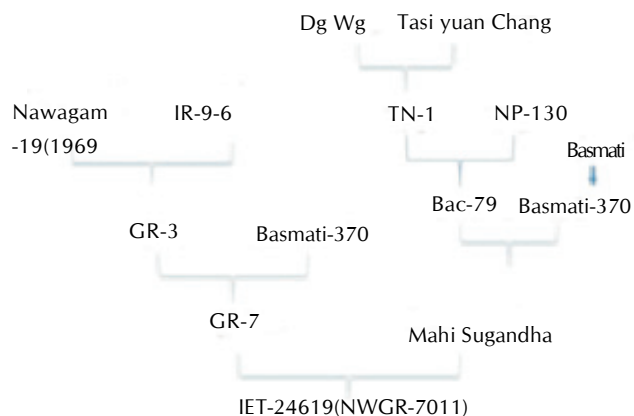


Figure 1: Parentage with details of pedigree and land races

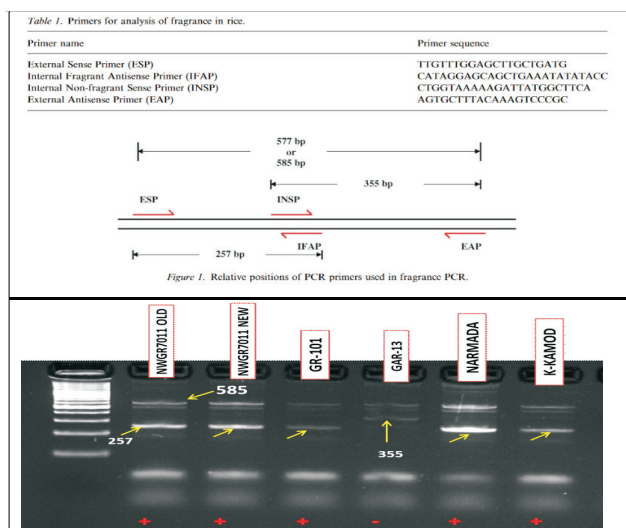


Figure 2: Aroma testing of six cultures of rice

locations in Gujarat and Maharashtra and AVT I ASG conducted during *Kharif* 2015 on two different locations of Gujarat and Maharashtra, exhibited second rank with significantly higher yield of 68.75 and 42.81 percent over the regional and local check varieties, respectively. In third year of AVT II ASG trial resulted yield increment significantly higher grain yield of 15.5 and 24.3 per cent over qualifying entries IET 24621 and IET 24613, respectively. In western region, tested over two different locations of Gujarat and Maharashtra and found fourth rank with yield increment of 12.2, 9.1 and 21.8 percent over the national, regional and local checks, respectively (Anonymous, 2018a). The Gujarat Anand Rice 14 (IET 24619) was tested in 6 considerable trials conducted over 3 years at different 4 locations of Gujarat and Maharashtra in western region of India (Table 1). The different state experiments were conducted from *Kharif* 2009 to *Kharif* 2013 and overall mean grain yield of NWGR 7011 was recorded 4136 Kg/ha with yield increment compared to GR 101 and Krishna Kamod, 8.7 % and 96.9 % , respectively (Table 3).

The overall mean performance of grain yields from *Kharif* 2014 to *Kharif* 2016 of GAR 14 was recorded the highest *viz.*, 5108

Table 1 : Mean yield of IET-24619 (GAR-14) in coordinated varietal trials (ASG) of western zone VI (Gujarat and Maharashtra)

Parameter	Year of Testing	No. of trials @/ Location	Zone	Grain Yield kg/ha			Qualifying Varieties			C.D 5%	C.V. %	
				IET-24619	National check	Regional check	Local check	IET-24613	IET-24617			IET-24621
Mean grain yield kg/ha	2014 IVT-ASG	2/04	VI	6022	2749	3529	3396	5691	5345	4281	730	12.57
	2015 AVT-I ASG	2/18	VI	4897	4961	2902	3429	3939	4721	4238	376	9.13
	2016 AVT-II ASG	2/21	8 zones except I	4406	3926	4038	3617	4967	4640	3942	595	8.62
			Mean		5108	3879	3490	3480	4865	4902	4153	
Per cent increase over checks	2014 IVT-ASG	2/4	VI	-	119.06*	70.64*	77.33*	5.8	12.7	40.7*		
	2015 AVT-I ASG	2/18	VI	-	-	68.75*	42.81*	24.3*	3.7	15.5*		
	2016 AVT-II ASG	2/21	8 zones except I	-	12.23	9.11	21.81*	-	-	11.8		
			Overall Per cent increase		31.68	46.36	46.78	4.99	4.2	22.99		
Frequency in top 5 group	2014 IVT-ASG	2/4	VI	2/2	0/2	0/2	0/2	2/2	2/2	0/2		
	2015 AVT-I ASG	2/18	VI	½	2/2	0/2	0/2	0/2	½	½		
	2016 AVT-II ASG	2/21	8 zones except I	1/2	0/2	1/2	0/2	2/2	2/2	1/2		
			Total	4/6	2/6	1/6	0/6	4/6	5/6	2/6		

@ indicating test under different locations of India, but considerable data are each of two centre, only. In 2014 only two locations Radhanagari, Nawagam; in 2015 only two locations Pondaghat, Nawagam and in 2016 two locations Pondaghat, Navasari were considered

* indicating that the proposed variety IET-24619 (GAR-14) is significantly superior to the respective checks in grain yield; Year : 2014-15: NC- Badhabhog, RC- Kalanamak, LC- Krishna Kamod (Guj.) PKV-Makarand (SND) Phondaghat-1 (PDG), Ambemohar-157 (RDN); Year: 2015-16: NC- Shobini, RC- CR Sugandh Dhan-907, LC- Krishna Kamod (Guj.), Phondaghat-1 (PDG), Ambemohar-157 (RDN); Year: 2016-17: NC- Shobini, RC- CR Sugandh Dhan-907, LC- GR-104(Guj.) Ratnagiri-5 (PDG)

Table 2 : Comparative yield attributing traits of IET-24619 (GAR-14) of western zone VI and mean over locations

Sr. No.	Item	Year	Zone	IET-24619	National Check	Zonal check	Local check	Qualifying varieties			CD 5%	CV %
								IET-24613	IET-24617	IET-24621		
1	Days to 50 % flowering	2014	VI	107	118	110	101	113	106	102	1	0.49
		2015	VI	110	106	118	107	109	106	100	0	0.45
		2016	*	108	107	105	99	107	103	107	-	-
			Mean	108.3	110.3	111	102.3	109.7	105	103		
2	Days to maturing	2014	VI	137	148	140	131	143	136	132	1	0.48
		2015	VI	140	136	148	137	139	136	130	0	0.46
		2016	*	138	137	135	129	137	133	137	-	-
			Mean	138.3	140.3	141	132.3	139.7	135	133		
3	Plant height (cm)	2014	VI	108	158	136	125	106	106	97	0	0
		2015	VI	105	101	96	123	108	102	98	0	-
		2016	*	117	110	119	130	105	118	104	-	-
			Mean	110	123	117	126	106.3	108.7	99.7		
4	Numbers of panicles/m ²	2014	VI	274	234*	255	253*	267	257	258	22	8.44
		2015	VI	253	237*	228*	267	268	253	238*	13	5.6
		2016	*	284	275	259	257	299	266	276	-	-
			Mean	270.3	248.7	247.3	259	278	258.7	257.3		

Note: * indicating 8 zones of Rice in India except I Zone

Year : 2014-15: NC- Badhabhog, RC- Kalanamak, LC- Krishna Kamod (Guj.) PKV-Makarand (SND) Phondaghat-1 (PDG), Ambemohar-157 (RDN); Year: 2015-16: NC- Shobini, RC- CR Sugandh Dhan-907, LC- Krishna Kamod (Guj.), Phondaghat-1 (PDG), Ambemohar-157 (RDN); Year: 2016-17: NC- Shobini, RC- CR Sugandh Dhan-907, LC- GR-104(Guj.) Ratnagiri-5 (PDG)

Table 3: Mean grain yield of genotype NWGR-7011 (GAR 14) in State trials, Gujarat

Year	Expt.	Locations	Grain yield (kg/ha)			
			NWGR 7011	GR101	GR104	K.K. Narmada
2009	PET Aro.	NWG, DAB	5776	4927	6237	5662
2010	SSVT Aro.	NWG, DAB	3127	4603	4522	4039
2011	LSVT Aro.	NWG, DAB	4053	3688	4375	4516
2012	LSVT Aro.	NWG, DAB, NVS, THA	4518	2827	3715	4144
2013			3205	2972	4081	3278
		Mean Over Location (12)	4136	3803	4586	4328
		% increase over check		8.7	-	96.9

Note: 1. NWG = Nawagam, DAB = Dabhoi, NVS = Navsari, THA = Thasara locations; 2. GR 101 = Gujarat Rice 101, GR 104 = Gujarat Rice 104, K.K. = Krishna Kamod; 3. LSVT indicating large scale varietal trial of state and PET indicating preliminary evaluation trial of state.

kg/ha and ranked 4/6 among top five in all the entries. The yield increase was 31.68, 46.36 and 46.78 per cent higher over national (3879 kg/ha), regional (3490 kg/ha) and local check (3480 kg/ha) varieties, respectively which may be due to higher number of panicles/m² (270.3). The yield attributing traits of Gujarat Anand Rice 14 are good viz., number of panicles/sq.mt (253-284), number of productive tillers (7.5),

test weight (16g) and length of panicles (26.6cm.) Table 4. This is in accordance to finding of Keerthiraj et al. (2020) that seed yield is also a complex trait the expression of which depends upon various yield contributing traits such as test weight, length of panicle, number of panicles and number of tillers with positive association and high direct effects on yield. The yield potential of this variety is 6022 kg/ha (Table 1). The Gujarat

Table 4: Morphological traits of NWGR-7011 (mean of 2011 to 2013) of LSVT state trials over location

Characters	NWGR 7011(GAR 14)	GR 101	GR 104	K.K.	Narmada
Panicle length (cm)	26.6 (25.6-27.8)	26 (26.1-27.5)	28 27.0-30.0	28.4 (25.6-28.5)	27.7 (25.5-28.6)
No. of productive tillers/ Plant	7.5 (7.0-9.0)	9 (7.0-8.0)	9 (8.0-10.0)	7.5 (7.0-8.0)	9 (8.0-10.4)
1000 grain wt. (g)	16 (18.7-20.0)	19.3 (19.2-19.4)	19 18.0-20.0	17.5 (17.0-18.0)	19.3 (19.2-19.6)
Classification	Medium	Fine	Long slender	Fine	Medium
Lodging problem	None lodge	None lodge	None lodge	Prone to lodge	None lodge
Spikelet	Awnless	Tiped awn	Awnless	Awned	Tiped awn
Foliage	Green with strong culm	Green and erect	Green	Green	Green
Cooking	Good	Good	Good	Good	Good
Threshability	Non shattering and Easy to thresh				

Table 5: Adaptability to agronomic variables conducted during Kharif 2016

N Levels/Varieties	Grain Yield (t/ha) over locations		Mean (t/ha)	Per cent increase over 100% RDN
	Nawagam	Karjat		
N Levels				
N1 (50% RDN)	5.24	2.87	4.06	-
N2 (100% RDN)	4.93	3.82	4.38	-
N3 (150% RDN)	5.48	4.29	4.89	11.6
C.D. (0.05 %)	NS	0.07		
C.V. %	16	3		
Varieties				Per cent increase over Ketekijoha (ZC)
IET 24619	5.53	3.65	4.59	18.6
IET-24613 (QV)	6.39	3.78	5.09	31.5
IET-24617 (QV)	5.09	3.53	4.31	11.4
Shobini (NC)	-3.65	3.65	-	
Ketekijoha (ZC)	4.14	3.61	4.71	-
Local Check	4.32	3.73	4.03	-
C.D. (0.05 %)	0.79	0.1		
C.V. %	15	4		

RDF of Nawagam = 100:25:0:25 kg/ha (N: P: K: Zn); RDF of Karjat = 120:50:50:25 kg/ha(N: P: K: Zn)

Table 6: Diseases reactions of IET-24619 (GAR-14) against major diseases (SI)

Disease Name	Screening method	Year	IET-24619	Kala Namak (NC-1)	Shobini (NC-2)	Gontra Bidhan-3(NC-3)	CRS. D-907 (RC)	Dubraj (QC)	Badshah Bhog	Keteki Joha	Qualifying Variety		
											IET-24613	IET-24617	IET-24621
Bacterial Leaf Blight (BLB)	Natural	2014-15	3.1	4.0	-	-	-	-	-	-	5.0	4.0	7.0
	Artificial	2015-16	3.7	-	4.30	-	3.0	-	2.3	-	3.6	3.0	5.6
		2016-17	6.0	-	-	5.0	-	6.0	-	4.0	5.0	5.0	5.0
	Mean		4.3	4.0	4.3	5.0	3.0	6.0	2.3	4.0	4.5	4.0	5.9
Sheath Rot(SR)	Natural	2015-16	0.0	-	3.0	-	0.0	-	5.0	-	3.0	0.0	5.0
	Artificial	2015-16	7.0	-	7.0	-	7.0	-	7.0	-	5.0	7.0	7.0
		2016-17	7.0	-	-	7.0	-	7.0	-	7.0	5.0	5.0	7.0
	Mean		7.0	-	7.0	7.0	7.0	7.0	7.0	7.0	5.0	6.0	7.0
Leaf Blast(LB)	Natural	2014-15	7.0	5.0	-	-	-	-	-	-	7.0	7.0	5.0
		2015-16	6.0	-	3.0	-	5.5	-	4.5	-	3.0	4.5	4.0
		2016-17	7.0	-	-	0.0	-	6.0	-	8.0	9.0	8.0	7.0
	Mean		6.7	5.0	3.0	0.0	5.5	6.0	4.5	8.0	6.3	6.5	5.3
	Artificial	2016-17	8.0	-	-	6.0	-	8.0	-	7.0	0.0	0.0	7.0
	Mean		8.0	-	6.0	-	8.0	-	7.0	0.0	0.0	7.0	
Neck Blast(NB)	Natural	2014-15	-	-	-	-	-	-	-	-	-	-	-
		2015-16	1.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0
		2016-17	-	-	-	-	-	-	-	-	-	-	-
	Mean		1.0	-	0.0	-	0.0	-	0.0	-	0.0	0.0	0.0
	Artificial												

SES, IRRI, 1980

Damage Scale %

Growth stage

0

1

3

5

7

9

BLB
4-8
0
>1
1-5
6-25
26-50
51-100ShR
7-9
0
>1
1-5
6-25
26-50
51-100GD
8-9
0
>1
1-5
6-25
26-50
51-100FSm
7-9
0
>1
1-5
6-25
26-50
51-100

Table 6a :Reactions of IET-24619 (GAR-14) against major Insect Pests (Per cent damage)

Insectname	Screening method	Item	IET-24619	Shobini (NC)	Gontra bidhan (ZC)	Latest Release Check(RC)	Local check	Qualifying Varieties			
								IET-24613	IET-24617	IET-24621	
Gall Midge Borer-4	Natural	2014-15	-	-	-	-	-	-	-	-	
		2015-16	90	90	-	9.5	-	100.0	100.0	95.0	
		2016-17	90	-	75	-	-	70.0	90.0	50.0	
		Mean	90	90	75	9.5	-	85.0	95	72.5	
Stem Borer	Artificial	Not tested in artificial condition									
		Dead Hearts (Natural)	2014-15	-	-	-	-	-	-	-	-
			2015-16	14.3	0.3	-	0.0	-	27.3	0.00	0.00
			2016-17	-	-	-	-	-	-	-	-
	Mean	14.3	0.3	-	0.0	-	27.3	0.00	0.00		
	% White Ears(Natural)	2014-15	-	-	-	-	-	-	-	-	
		2015-16	23.6	19.75	-	20.40	-	15.50	20.95	40.90	
		2016-17	-	-	-	-	-	-	-	-	
Mean		23.6	19.75	-	20.40	-	15.50	20.95	40.90		
Leaf Folder	Natural	2014-15	-	-	-	-	-	-	-		
		2015-16	-	-	-	-	-	-	-		
		2016-17	11.90	-	6.90	-	-	13.20	0.00	13.00	
		Mean	11.90	-	6.90	-	-	13.20	0.00	13.00	
	Artificial	Not tested in artificial condition									
		2014-15	Not tested in artificial condition								
Damage Scale %	BPH(NVS)			SB			LF				
Growth stage	2-9			2-4			2-9				
0	0			0			0				
1	>5			1-20			1-10				
3	5-10			21-40			11-20				
5	11-20			41-60			21-35				
7	21-40			61-80			36-50				
9	>40			81-100			50-100				

Table 7: Quality characteristics of IET-24619 (GAR-14) along with checks (Mean over three years Kharif 2014-2016)

Quality Parameters	IET-24619 (GAR-14)	Shobini (NC)	Badshabhog (ZC)	Dubraj (QC)	Kalanamak (QC)	Qualifying varieties		
						IET-24613	IET-24617	IET-24621
HULL	81.4	76.3	78.1	78.1	80.8	80.5	78.2	80.3
MILL	70.1	63.1	69.6	65.1	74.7	69.3	66.4	67.4
HRR	64.9	54.9	62.9	63	65.3	63.4	64.3	65
KL	5.66	5.21	3.99	5.21	5	5.49	4.89	5.36
KB	1.78	1.67	1.94	2.18	1.82	2.03	1.9	1.86
L/B	3.19	3.12	2.05	2.39	2.75	2.71	2.57	2.87
VER	4.7	5.2	4.7	5.3	4.9	4.7	4.5	4.8
WU	281.7	247.5	235	270	262.5	240	178.3	226.7
KLAC	9.1	8.6	6.7	9.8	8.8	8.9	8.4	9.2
ER	1.6	1.65	1.67	1.89	1.74	1.62	1.71	1.71
ASV	4	4.5	4.7	4	6	3.6	3.2	3.2
AC	23.4	23.5	21	25.7	24.5	24	21.9	23.9
(Amylose content)								
GC	45	27	51	44	65	52.3	22	47.7
GT**	SS [#]	SS [#]	SB	SB	MS [#]	MS [#]	MS [#]	MS [#]
Grain Chalk	VOC/A/VOC	A/VOC/A	VOC/VOC /VOC	A/VOC/A	VOC /- / VOC	A/VOC/A	A/ VOC/A	VOC/ VOC/A
*Aroma	SS/SS/SS	-/MS/SS	SS/SS/SS	SS/MS/SS	MS/- /SS	MS/MS/NS	SS/MS/NS	SS/MS/SS

Hull: Hulling (%); Mill: Milling (%); HRR: Head Rice Recovery (%); KL: Kernel Length(mm); KB: Kernel breadth(mm); L/B: Length and breadth ratio; Grain Chalk: Grain Chalkiness; VOC: Very occasionally present; A: Absent; KLAC: Kernel length after cooking; WU: Water uptake; VER: Volume expansion ratio; ER: Elongation ratio; ASV: Alkali spreading Value; AC: Amylose content (%); GC: Gel consistency; GT: Grain type; SB: Short bold; MS[#]: Medium slender; SS[#]: Short slender; NS : Non scented, MS: Medium scented, SS: Strongly scented + indicating the grain weight of GAR-14 is 17.0 gm.

Note: * Indicating that the identified culture IET-24619 was found **Strongly Scented** in all three years of testing carried out at ICAR-IIRR, Hyderabad, as per Progress reports of AICRIP (2014-2016)

Anand Rice14 (IET-24619) is found early in flowering (108 days) compared to zonal and national check varieties and at par of two other varieties of qualifying and checks varieties. The Gujarat Anand Rice 14 was mid late maturing (DFF 107-110 days and seed to seed 137-140 days). The differences may be attributed to lower up to 15 days compared to late

aromatic varieties. It was found medium tall (110 cm height) followed by three check varieties which is desirable character in paddy and remaining three found tall out of six varieties. The plant height ranged to 105-117 cm. That is desirable over the check varieties (Table 2); these results are in agreement with those obtained by Sedeek *et al.* (2009).

The Gujarat Anand Rice 14 culture is medium tall erect, green foliage, awnless grains with non-shattering grain habit. The grain possesses 16.0 g test weight, 5.66 mm grain length with breadth 3.19 mm having kernel length/breadth (mm) ratio of 3.19 that is enough categorised in medium slender kernel type group (Table 7). The grain size and shape are the first criteria of rice quality for developing new varieties for commercial production (Adair *et al.*, 1966). The grain quality characteristics of the Gujarat Anand Rice 14 was derived at MRRS, Nawagam and Indian Institute of Rice Research, Hyderabad that was started in Table 7.

The amylose content of Gujarat Anand Rice 14 found intermediate (23.43%) where; intermediate amylose most preferred in the rice growing areas in the world, except where low-amylose japonicas are grown. The high head rice recovery (64.9 %) and medium gel consistency of GAR 14 is 45 mm. An estimate of the gelatinization temperature for GAR 14 was indexed medium slender by the alkali digestibility test (Little *et al.*, 1958) which was measured by the alkali spreading value (4.0). Grain elongation appears to be a quantitative trait and found the elongation ratio of 1.6 derived through method of Azeez and Shafi (1966). The Hulling %, milling quality and head rice recovery of GAR 14 found 81.4%, 70.1% and 64.9%, respectively (Table 7); which is desirable similarly accord with Nath *et al.* (2019) that rice miller's preference of 80% Hulling, 70% milling and 65% head rice recovery. The head-rice recovery may vary from as low as 25 per cent to as high as 65 per cent accord Khush *et al.* (1979) but stable in GAR 14 found around 64.9 % and strongly scent was realize by a simple laboratory technique employed to evaluate rices followed as per method developed at IRRI (1971). The samples were scored through organoleptic testing (smelling) marked as strongly aromatic, moderately aromatic, slightly aromatic and non aromatic, scored strongly aromatic and Gujarat Anand Rice 14 variety found strongly aromatic. Brown rice samples are used with the cooking time increased up to 30 minutes. The IET 24619 (GAR 14) got strong aroma during testing both of method *viz.*, organoleptic test and confirmed by using aroma specific marker generated for aroma by AFLP marker found positive during testing of six cultures of rice (Fig.2). Similarly, findings accord with popular ten aromatic rice varieties of Bangladesh were studied for grain quality, among these particularly, Kataribhog was preferred more due to its medium size and short bold and Badshahbog is suitable in respect of higher head rice out turn and strong aroma (Hossain *et al.* (2008).

The agronomical performance of nitrogenous fertilizers of Gujarat Anand Rice 14 (IET 24619); tested on different graded levels of recommended N fertilizer (RDF of Nawagam = 100:25:0:25 kg/ha (N: P: K: Zn); RDF of Karjat = 120:50:50:25 kg/ha (N: P: K: Zn) and it was found higher grain yield over the zonal check variety across the locations *i.e.* 4.59 t/ha and 18.6 per cent yield increase over Ketakijoha. Nitrogen level N₃ (150% RDN) gave significantly highest grain yield than the rest of nitrogen levels at Karjat location, while N₃ level at Nawagam location recorded the higher grain yield among the different graded N levels which reveals highly responsive to nitrogenous fertilizer (Table 5) (Anonymous, 2018a). In contrast to report of Gupta *et al.* (2019) that mostly,

yields of traditional "Basmati" are lower than high yielding varieties like Pusa Basmati 1121, which are primarily exported from the country and unable to withstand higher rates of N fertilizer as they are prone to lodging. Whereas, Gujarat Anand Rice 14 found high yielding, highly responsive to nitrogenous fertilizer and none lodging plant type.

In case of diseases, bacterial leaf blight, leaf and neck blast are the major diseases of the paddy, whereas grain discoloration, sheath rot and stem rot are the minor diseases. Screening of rice genotypes followed as per methodology suggested by Kalode *et al.* (1979). The variety was tested for important of rice and showed particularly moderate resistant to bacterial leaf blight, sheath rot, leaf blast and resistant to neck blast (Table 6). The observations were recorded based on 0-9. The observations of plant were taken on the basis of visual plant damage symptoms (0-9 scale) which are followed by probing mark test was carried out according to methodology suggested by Natio (1964). The *per cent* damage due to gall midge (GMB), stem borer and leaf folder found moderate in IET 24619 than check varieties and different qualifying varieties; this indicated that GAR 14 is moderately tolerant to all above insect-pests (Table 4a).

The variety identification committee (VIC) identified the GAR 14 for its release for the states of Maharashtra and Gujarat on April 14, 2018, ICAR-Indian Institute of Rice Research, Hyderabad and Central Varietal Release Committee notified for its release of variety for Agricultural Crops during meeting on 10th August, 2018 at Krishi Bhavan, New Delhi (Anonymous, 2018b).

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