



Varietal suitability of grape in different agro-climatic regions of India

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ABSTRACT

Grape cultivation, in India, is dependent on a narrow range of table grape varieties, with more than 70 per cent cultivated area in Maharashtra alone, followed by Karnataka and Tamil Nadu. Therefore, to increase the scope of area extension under grape cultivation, the suitability of six coloured grape varieties was assessed for yield, quality and phenological parameters at four locations, *i.e.*, Pune (Maharashtra), Arabhavi (Karnataka), Rajendranagar (Telangana) and Theni (Tamil Nadu) during 2019-2022. From the study, it was revealed that the 'Manjari Shyama' and 'Red Globe' yielded the maximum (13.7 kg/vine) as compared to the rest of the varieties. Variety 'Manjari Shyama' was found stable at all four locations for yield, bunch weight, 100-berry weight, berry diameter, TSS, acidity, sugar: acid ratio and days to veraison with the regression coefficient 1.22, 1.11, 1.01, 1.13, 1.35, 1.44, 0.88 and 0.79, respectively. The yield and bunch weight in 'Red Globe' was found to be more expressive under the favourable environment as compared to 'Fantasy Seedless' (5.59 kg/vine), 'Nanasaheb Purple Seedless' (6.13 kg/vine) and 'Crimson Seedless' (7.63 kg/vine), which were found lower.

Key words: *Vitis vinifera*, Suitability, Stability, Yield, Phenology

INTRODUCTION

The Indian table grape industry is solely dependent upon a few commercially grown varieties, including 'Thompson Seedless' and 'Sharad Seedless' and their clones. In 2021, India produced 3229 thousand metric tonnes of grapes from an area of 152 thousand hectares, mainly from Maharashtra, Karnataka, Telangana, Tamil Nadu and others 2021 (Patil and Chavan, 13; Nikumbhe *et al.*, 12). It was exported during the year 2020-21 to the tune of 246.11 thousand MT (APEDA, 2). Simultaneously, the domestic market offers a big platform for the grape industry. However, the expansion of any crop variety is dependent on consumer preference, ease of cultivation and profit margin. Consumer preferences in international and domestic markets are mainly based on coloured grape varieties. Under the current Indian Viticulture scenario, 'Sharad Seedless' and its clones are being grown commercially under the coloured category. However, the area under coloured varieties is comparatively less than the white types due to quality and marketing-related issues.

Further, the introduction of new varieties abides by the various legalities. A few decades before, some coloured grape varieties were introduced in

India, including 'Red Globe', 'Crimson Seedless', and 'Fantasy Seedless' to enrich the varietal basket (Gawande, 7). Also, some Indian-origin cultivars, such as 'Nanasaheb Purple Seedless' and 'Manjari Shyama', are being cultivated in a few patches of Maharashtra. However, the adaptability and performance stability of these cultivars were not tested under other regions of the country having different agro-climatic conditions.

Environment imposes a significant impact on the physiology of vines as well as their productivity (Merril *et al.*, 10). Additionally, viticulture practices are strongly influenced by vine productivity and fruit quality. To expand the area under grapes and to meet the increasing demand, varietal suitability under various agro-climatic zones is an essential point of consideration. Therefore, some of the potential coloured table grape varieties were tested for their suitability for growing under various agro-climatic regions of Maharashtra, Karnataka, Tamil Nadu, and Telangana of India.

MATERIALS AND METHODS

Six coloured grape varieties (Red Globe, Fantasy Seedless, Crimson Seedless, Manjari Shyama, Nanasaheb Purple Seedless and Sharad Seedless) were evaluated at four agro-ecological zones for their performance and suitability through ICAR-All India Coordinated Research Project (Fruits) trials from 2019-2022. The experiment was laid out in a randomized block design with four replications.

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Vines were planted at the spacing of 2.7 m × 1.5 m, which allowed them to develop their canopies on the Y trellises system. Observations were recorded on yield (kg/vine), number of bunches per vine, bunch weight (g), 100-berry weight (g), berry diameter (mm), total soluble solids-TSS (°B), acidity (%), sugar: acid ratio, days to veraison (number of days) and days to harvest (number of days). Locations and varieties used in experiments are as follows:

Locations: Pune (Maharashtra; 18° 29' N longitude, 73° 59' E latitude and 559 m altitude), Arabhavi (Karnataka; 16° 49' N longitude, 75° 43' E latitude and 547 m altitude), Rajendranagar (Telangana; 17° 25' N longitude, 78° 25' E latitude and 545 m altitude), and Theni (Tamil Nadu; 09° 45' N longitude, 77° 21' E latitude and 448 m altitude).

Varieties *viz.*, Red Globe, Fantasy Seedless, Crimson Seedless, Manjari Shyama, Nanasaheb Purple Seedless and Sharad Seedless (check) were grafted on 'Dogridge' rootstock.

The pooled data (three cropping seasons) was statistically analyzed using the OPSTAT software (Kulkarni *et al.*, 9). The stability of varieties was assessed using the linear regression model described by Eberhart and Russell (5).

RESULTS AND DISCUSSION

The performance of six coloured table grape varieties was tested for their suitability for cultivation in Maharashtra, Karnataka, Telangana, and Tamil Nadu agro-ecological regions. Grapes are being cultivated in these regions but saturated with a single traditional variety. Some of the region-specific popular coloured grape varieties include Sharad Seedless and its clones in Maharashtra and Gulabi and Red Globe in Karnataka and Tamil Nadu (Goswami *et al.*, 8; Somkuwar *et al.*, 16). Therefore, to add to the varietal collection, the suitability of potential coloured grape varieties was assessed to meet the market demand.

Data were collected for yield, bunch, berry and other phenological growth stages. All varieties were well supported by the climatic conditions of locations and got sufficient period to complete the cropping cycle from pruning to harvest. However, the performance of varieties varied from location to location. At Pune, 'Manjari Shyama' achieved maximum yield (19.0 kg/vine) (Table 1) with an average bunch weight of 353.4 g and the number of bunches was 75.7 bunches/vine. It has also attained more than 18 mm berry diameter size with the use of plant growth regulators. Satisfactory yield was also recorded in 'Red Globe' (11.2 kg/vine) on account of higher bunch weight (637.0 g) and larger berry size (25.3 mm). Among the seedless varieties, 'Crimson Seedless' and 'Fantasy Seedless'

were subjected to the gibberellic acid application (<3.0 ppm) for rachis elongation only, as higher concentration led to a detrimental effect in the form of rachis coiling and increase in berry shattering at the time of harvest. The result was also supported by the finding of Satisha *et al.* (15) regarding the application of gibberellic acid concentration in 'Crimson Seedless' for bunch and berry quality. However, the problem of fruitfulness was experienced in the 'Crimson Seedless', 'Fantasy Seedless' and 'Nanasaheb Purple Seedless'. Lower yields in 'Crimson Seedless' and 'Fantasy Seedless' might have resulted from the vigorous nature of the varieties (Abdel-Mohsen, 1). Dokoozilian *et al.* (4) illustrated the vigorous vine habit of 'Crimson Seedless' when planted in deep fertile soils and suggested avoiding the extravagant application of nitrogen and irrigation. Management of these factors offers the chance to improve upon the fruitfulness issue if phenological stage-specific water requirements of these varieties are worked out about soil and climatic conditions. The study on potential and actual bud fruitfulness conducted by Ferrara and Mazzeo (6) supports these findings and explains the vital role of the environment, particularly temperature, on bud fertility.

The total soluble solids ranged from 17.7 to 20.0°Brix, while the acidity ranged from 0.44 per cent (Red Globe) to 0.68 per cent (Sharad Seedless). All varieties were able to attain a suitable sugar-acid ratio (>25) for table purposes. 'Red Globe' was last to achieve veraison (109 days) and harvest stage (144 days), followed by 'Crimson Seedless'. In comparison, less than 130 days were taken by 'Nanasaheb Purple Seedless', 'Manjari Shyama', 'Fantasy Seedless' and 'Sharad Seedless' for harvesting of bunches (Gawande, 7).

The trend in performance of these varieties varied at the Arabhavi Centre. Concerning yield, 'Crimson Seedless' and 'Red Globe' outperformed with an average of 10.8 and 10.2 kg yield per vine, respectively. However, the number of bunches per vine was recorded as highest in 'Manjari Shyama' (30.8) and 'Crimson Seedless' (24.0). The highest bunch weight (491 g) and 100-berry weight (459 g) were recorded in 'Red Globe', while it ranged between 270-346 g and 214-269 g, respectively, in other seedless varieties. Excluding 'Red Globe', berry diameter ranged between 16.2-16.8 mm. But being gibberellic acid responsive varieties, 'Manjari Shyama', 'Nanasaheb Purple Seedless' and 'Sharad Seedless' can be improved for berry diameter through interventions of stage-specific application of plant growth regulators and berry thinning operations. 'Red Globe' and 'Crimson Seedless' were late in maturity, while other varieties took around 135 days to achieve ≥ 20°B.

Performance of Coloured Grape Varieties in India

Table 1. Analysis of variance of six coloured table grape varieties at four locations.

Location	Parameter	Yield (kg/vine)	No. of bunches/vine	Bunch weight (g)	100-berry weight (g)	Berry diameter (mm)	TSS (°B)	Acidity (%)	Sugar: acid ratio	Days to veraison	Days to harvest
Pune	Variety										
	RG	11.20 ^b	23.10 ^{bc}	637.00 ^a	647.00 ^a	25.30 ^a	17.70 ^f	0.44 ^f	38.40 ^a	109.00 ^a	144.00 ^a
	FS	5.13 ^{cde}	19.90 ^{bcd}	288.00 ^{de}	258.00 ^{def}	17.30 ^{cde}	18.90 ^{abcde}	0.56 ^{cd}	33.90 ^{bc}	93.10 ^f	128.00 ^{cd}
	CS	3.55 ^{ef}	15.30 ^{bcdef}	241.00 ^{ef}	406.00 ^{bcd}	17.10 ^{ef}	19.10 ^{abc}	0.66 ^{ab}	29.80 ^{cdef}	105.00 ^b	142.00 ^b
	MS	19.00 ^a	75.70 ^a	353.00 ^{bcd}	450.00 ^{bc}	19.60 ^c	20.00 ^a	0.54 ^{cde}	32.50 ^{bcd}	96.20 ^e	128.00 ^{cde}
	NPS	5.48 ^{cd}	19.50 ^{bcd}	392.00 ^b	595.00 ^{ab}	23.60 ^{ab}	19.40 ^{ab}	0.62 ^{abc}	34.10 ^b	103.00 ^c	127.00 ^{def}
	SS	8.58 ^{bc}	28.10 ^b	371.00 ^{bc}	326.00 ^{de}	19.50 ^{cd}	19.00 ^{abcd}	0.68 ^a	30.10 ^{bcd}	101.00 ^{cd}	129.00 ^c
	C.D.	3.72	18.10	99.30	190.00	2.32	1.15	0.08	4.26	2.18	1.70
	C.V. (%)	22.90	32.40	14.20	23.00	6.18	3.27	7.83	6.97	1.17	0.69
Arabhavi	RG	10.20 ^{ab}	15.10 ^c	491.00 ^a	459.00 ^a	23.80 ^a	18.70 ^e	0.69 ^a	27.30 ^f	96.20 ^a	142.00 ^b
	FS	3.65 ^f	12.40 ^{cd}	270.00 ^f	214.00 ^{ef}	16.80 ^b	20.90 ^{bc}	0.53 ^e	39.10 ^a	87.70 ^{def}	135.00 ^{de}
	CS	10.80 ^a	24.60 ^{ab}	319.00 ^d	255.00 ^c	16.40 ^{bc}	19.50 ^d	0.61 ^{cd}	31.70 ^{de}	89.70 ^{de}	145.00 ^a
	MS	9.23 ^{bc}	30.80 ^a	346.00 ^b	218.00 ^e	16.40 ^{bc}	21.40 ^a	0.61 ^{cd}	35.20 ^b	90.70 ^d	135.00 ^{cd}
	NPS	5.67 ^{de}	12.40 ^{cd}	339.00 ^c	269.00 ^b	16.20 ^{cd}	21.10 ^{ab}	0.62 ^c	33.80 ^{bc}	94.10 ^{ab}	138.00 ^c
	SS	5.71 ^d	11.70 ^{cde}	297.00 ^e	226.00 ^d	16.20 ^{cd}	20.90 ^{bc}	0.65 ^b	32.10 ^d	94.00 ^{abc}	130.00 ^{cd}
	C.D.	1.23	7.23	5.68	4.30	0.47	0.39	0.03	1.64	4.80	2.91
	C.V. (%)	8.86	22.00	0.90	0.85	1.45	1.05	2.81	2.68	2.83	1.14
	Rajendranagar	RG	27.20 ^a	37.80 ^{ab}	740.00 ^a	649.00 ^a	19.60 ^a	16.70 ^e	0.80 ^a	22.70 ^f	121.00 ^a
FS		6.90 ^{def}	21.10 ^{def}	315.00 ^{def}	406.00 ^{bc}	18.50 ^{bc}	21.30 ^a	0.57 ^f	34.50 ^a	102.00 ^e	126.00 ^{def}
CS		10.50 ^d	28.20 ^{bcd}	356.00 ^{cd}	365.00 ^{cd}	16.40 ^e	18.50 ^{cd}	0.61 ^{de}	28.50 ^{bcd}	104.00 ^d	141.00 ^{ab}
MS		18.80 ^b	48.50 ^a	407.00 ^c	279.00 ^f	16.00 ^{ef}	20.00 ^b	0.65 ^c	30.70 ^b	106.00 ^b	127.00 ^{cde}
NPS		8.450 ^{de}	23.80 ^{de}	347.00 ^{cde}	441.00 ^b	18.60 ^b	19.60 ^{bc}	0.62 ^d	29.90 ^{bc}	99.50 ^f	127.00 ^{cd}
SS		16.20 ^{bc}	31.40 ^{bc}	528.00 ^b	353.00 ^{de}	17.70 ^d	20.00 ^b	0.70 ^b	27.30 ^{de}	105.00 ^c	128.00 ^c
C.D.		4.81	14.90	73.60	72.90	0.69	0.72	0.02	2.45	0.97	1.26
C.V. (%)		17.8	25.50	8.90	9.52	2.09	2.01	1.27	4.59	0.49	0.52
Theni		RG	6.07 ^{bc}	14.10 ^{ef}	413.00 ^a	466.00 ^a	20.70 ^a	18.30 ^{cde}	0.70 ^{ab}	26.40 ^{def}	101.00 ^b
	FS	6.67 ^b	21.20 ^{bc}	321.00 ^b	318.00 ^{cd}	14.90 ^{def}	20.70 ^a	0.51 ^f	38.60 ^a	92.90 ^c	124.00 ^c
	CS	5.65 ^{bcd}	24.70 ^b	218.00 ^{ef}	381.00 ^b	16.20 ^{cde}	19.60 ^b	0.64 ^{cd}	31.00 ^b	104.00 ^a	146.00 ^a
	MS	7.85 ^a	34.50 ^a	223.00 ^e	330.00 ^c	16.40 ^{cd}	19.00 ^{bc}	0.63 ^{cde}	30.10 ^{bc}	89.60 ^d	119.00 ^e
	NPS	4.90 ^{def}	16.10 ^{cde}	305.00 ^c	309.00 ^{cde}	18.20 ^b	18.90 ^{cde}	0.71 ^a	26.80 ^{cde}	86.00 ^e	123.00 ^{cd}
	SS	5.85 ^{bcd}	20.60 ^{bcd}	295.00 ^d	304.00 ^{def}	17.10 ^c	19.00 ^{bc}	0.67 ^{abc}	28.20 ^{bcd}	85.00 ^{ef}	117.00 ^f
	C.D.	1.40	4.76	9.53	20.70	0.96	0.72	0.06	3.33	2.24	1.61
	C.V. (%)	12.3	11.8	1.75	3.19	3.01	2.02	5.37	5.99	1.30	0.68

RG: Red Globe; FS: Fantasy Seedless; CS: Crimson Seedless; MS: Manjari Shyama; NPS: Nanasaheb Purple Seedless; SS: Sharad Seedless

Under Rajendranagar (Telangana) conditions, 'Red Globe' (27.2 kg/vine) exhibited very high vine productivity, followed by 'Manjari Shyama' (18.8 kg/vine) and 'Sharad Seedless' (16.2 kg/vine). The minimum yield was recorded in 'Fantasy Seedless' (6.9 kg/vine). Comparatively, higher vine productivity was recorded at this centre. An average of 740.3 g of bunch weight and 649.3 g of 100-berry weight were recorded in 'Red Globe'. Among the seedless varieties, the

average bunch weight varied between 315 g (Fantasy Seedless) and 528 g (Sharad Seedless). The berry diameter was observed in the stretch of 16.0 to 19.6 mm size. Relatively, 'Red Globe' was harvested at lower TSS (16.7°B) and higher acidity (0.80%) to avoid the coincidence of rains at harvest. The trend for the duration of harvest was similar to that of other locations.

Theni Centre in Tamil Nadu had comparatively lower yields in the varieties under evaluation. The

maximum yield was recorded in 'Manjari Shyama' (7.85 kg/vine) followed by 'Fantasy Seedless' (6.67 kg/vine), 'Red Globe' (6.07 kg/vine) and 'Crimson Seedless' (5.65 kg/vine). 'Red Globe' and 'Nanasaheb Purple Seedless' displayed low fruitfulness due to the reduced number of bunches and bunch weight. The average berry size recorded in 'Red Globe' was 20.7 mm, while it ranged between 14.9 mm (Fantasy Seedless) to 18.2 mm (Nanasaheb Purple Seedless) for the seedless varieties. 'Fantasy Seedless' was the earliest to achieve 18°B with the lowest acidity (0.51%). 'Crimson Seedless' took maximum days to harvest, followed by 'Red Globe'.

The differences in yield and quality parameters among the centres were mainly due to the combined effect of climatic impact and soil profile. The effect of temperature on berry size and weight was reported by Anastasiou *et al.* (3), who explained the spatiotemporal variability of table grape productivity with respect to quantity and quality.

The analysis of variance for stability indicated the significant mean squares among varieties for all morphological characters. At the same time, mean squares due to the environment were also found significant for morphological characters except for the number of bunches per vine. However, except yield, days to veraison and days to harvest, all other traits have shown non-significant G × E interactions. The result of Table 2 indicates the greater role of genotypic response in their performance. This outcome was also illustrated by the partitioning of the E × (G × E), where non-significant pooled deviation for morphological traits such as yield, bunches per vine and bunch weight specified lower interference of unknown factors affecting these characters noticed. However, the phenological stages of berry veraison and bunch harvest have shown the influence of locations due to varied weather parameters. The

results are in agreement with the findings of Rasoli *et al.* (14), who reported significant G × E interactions for various traits when 20 grape genotypes were evaluated under different locations. Such stability among six varieties was estimated by Eberhart and Russell (5) for their adaptability at four locations (Table 3). 'Red Globe' was found to perform better under favourable environmental conditions, as the regression coefficient for yield (2.47) and bunch weight (2.23) was more than 1.5. However, other traits such as number of bunches per vine (1.39), 100 berry weight (1.26), and berry diameter (1.36) have shown stability in performance in this variety. Although 'Fantasy Seedless' has represented the adaptive nature of the morphological traits with regression coefficient values (b) less than 0.5, it has performed below the pooled mean for yield, bunch number, bunch weight, 100-berry weight and berry diameter. The genotype was consistent in TSS recovery, acidity and sugar: acid ratio.

Likewise, 'Fantasy Seedless' and 'Crimson Seedless' showed low performance in terms of yield and related traits. In the stability analysis, 'Manjari Shyama' was estimated as the most stable genotype as all parameters reflected a regression coefficient near 1 value. The mean value for yield (13.7 kg/vine) and the number of bunches per vine (47.4/vine) were higher than the pooled mean. These findings suggested the wider adaptability of the 'Manjari Shyama'. Consistently unsatisfactory yield levels were exhibited by 'Nanasaheb Purple Seedless' (b=0.41). The variety has expressed superior berry diameter under favourable environmental conditions. Still, this trait in 'Nanasaheb Purple Seedless' is highly influenced by the use of plant growth regulators, which is a gibberellic acid-responsive variety. The check variety 'Sharad Seedless' manifested the yield in the range of pooled mean and responded as stable concerning

Table 2. Analysis of variance for stability for various traits of six coloured table grape varieties.

Source of variation	df	Yield	No. of bunches	Bunch weight	100-berry weight	Berry diameter	TSS	Acidity	Sugar: acid ratio	Days to veraison	Days to harvest
Variety	5	52.3*	482**	43,700**	38,434**	19.4**	3.35**	0.009 ^{NS}	31.4*	90.2*	232**
Environment	3	84.2*	269 ^{NS}	24,912**	35,150**	12.3*	2.26*	0.007 ^{NS}	27.7 ^{NS}	277**	103**
Var. × Environ.	15	16.0*	82.7 ^{NS}	4,118 ^{NS}	4,374 ^{NS}	2.33 ^{NS}	0.49 ^{NS}	0.004 ^{NS}	9.88 ^{NS}	23.8**	14.2**
Env+Var × Env	18	27.4 ^{NS}	114 ^{NS}	7,584 ^{NS}	9,503 ^{NS}	4.00 ^{NS}	0.79 ^{NS}	0.005 ^{NS}	12.8 ^{NS}	66.1**	29.0 ^{NS}
Env (Linear)	1	253**	808**	74,737**	105,451**	37.0**	6.78**	0.021**	83.1*	832 ^{NS}	309**
Env × Var (Lin)	5	30.7*	102 ^{NS}	8,489**	3,686 ^{NS}	2.72 ^{NS}	0.23 ^{NS}	0.011**	8.01 ^{NS}	15.0 ^{NS}	31.0**
Pooled Deviation	12	7.28 ^{NS}	60.9 ^{NS}	1,610 ^{NS}	3,931 ^{NS}	1.79*	0.52*	0.001 ^{NS}	9.01*	23.6**	4.83**
Pooled Error	20	5.95	92.2	2,267	6,145	1.03	0.37	0.002	5.58	4.97	2.29

*, ** Indicates significance against pooled deviation at P = 0.05 and P = 0.01 levels, respectively

Table 3. Stability parameters of six coloured table grape varieties.

Trait	Yield/vine (kg)			No. of bunches/vine			Bunch weight (g)			100-berry weight (g)		
	Mean	b	S ² _{di}	Mean	b	S ² _{di}	Mean	b	S ² _{di}	Mean	b	S ² _{di}
RG	13.7	2.47**	-1.77	22.5	1.39**	4.63	570	2.23**	27.8	556	1.26**	73.6
FS	5.59	0.17**	-0.18	18.7	0.45**	-33.1	298	0.02 ^{NS}	-268	299	0.54 ^{NS}	4,686
CS	7.63	0.43 ^{NS}	12.6	23.2	-0.16 ^{NS}	-2.13	284	0.73**	1,795	352	0.77**	-1,642
MS	13.7	1.22**	20.0	47.4	2.34 ^{NS}	204	332	1.11**	268	319	1.01**	2,500
NPS	6.13	0.41**	-2.83	18.0	0.70**	-43.2	346	0.30**	221	403	1.77**	1,852
SS	9.09	1.30**	-2.01	23.0	1.28**	-42.0	373	1.60**	816	302	0.65**	-2,316
Pooled mean	9.30			25.5			367			372		
	Berry diameter (mm)			TSS (°B)			Acidity (%)			Sugar: acid ratio		
	Mean	b	S ² _{di}	Mean	b	S ² _{di}	Mean	b	S ² _{di}	Mean	b	S ² _{di}
RG	22.4	1.36**	4.35	17.9	0.75 ^{NS}	0.57	0.66	4.27**	0.002	28.7	2.30 ^{NS}	29.2
FS	16.9	0.35 ^{NS}	2.38	20.5	0.86 ^{NS}	1.14	0.54	-0.04 ^{NS}	-0.00	36.5	0.18 ^{NS}	7.89
CS	16.5	0.25**	-0.52	19.2	0.28 ^{NS}	0.13	0.63	-0.41 ^{NS}	-0.00	30.3	0.38**	-0.88
MS	17.1	1.13**	-0.23	20.1	1.35**	0.22	0.61	1.44**	-0.001	32.1	0.88**	-0.29
NPS	19.1	2.04**	1.62	19.8	1.39**	-0.03	0.64	0.48 ^{NS}	0.002	31.1	1.34**	3.28
SS	17.6	0.86**	0.01	19.7	1.37**	0.001	0.68	0.26**	-0.001	29.4	0.91**	-1.88
Pooled mean	18.3			19.5			0.63			31.4		
	Days to veraison			Days to harvest								
	Mean	b	S ² _{di}	Mean	b	S ² _{di}	Mean	b	S ² _{di}	Mean	b	S ² _{di}
RG	107	1.55**	4.92	142	0.15*	2.33						
FS	94.1	0.80**	9.81	128	1.08*	-0.14						
CS	101	0.64**	50.0	143	-0.06 ^{NS}	8.81						
MS	95.8	1.09**	4.19	127	1.61**	0.55						
NPS	95.6	0.79**	33.0	129	1.46**	2.01						
SS	96.2	1.12**	24.4	127	1.76**	8.54						
Pooled mean	98.2			133								

RG: Red Globe; FS: Fantasy Seedless; CS: Crimson Seedless; MS: Manjari Shyama; NPS: Nanasaheb Purple Seedless; SS: Sharad Seedless

Regression Coefficient (b), Stability Parameter S²_{di}

yield (b=1.30), number of bunches (b=1.28), berry diameter (b=0.86), TSS (b=1.37), sugar: acid ratio (b=0.91) and days to veraison (b=1.12).

Considering the overall performance of the varieties based on yield, quality and performance stability, 'Manjari Shyama' found best to accomplish growers' and consumer's expectations. However, 'Red Globe' was found better under favourable environmental conditions, particularly in Rajendranagar and Arbhavi agro-ecological regions. Although the lower fruitfulness was recorded in 'Crimson Seedless' under most of the locations, the climatic and soil conditions of Arbhavi centre were well suited to 'Crimson Seedless'. Thus, the findings will support decisions for the expansion of grapes in various regions of India.

AUTHORS' CONTRIBUTION

Conceptualization of research (RS, PP, RG, SG, SN); Designing of the experiments (RS, PP, RG); Contribution of experimental materials (RG and RS), Execution of field/lab experiments and data collection (RS, ST, TBR and AS); Analysis of data (RS); Preparation of the manuscript (RS).

DECLARATION

The authors declare that they do not have any conflict of interest.

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