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VARIETAL RESPONSE OF DIFFERENT CULTIVARS AGAINST TWO-SPOTTED RED SPIDER MITES (*Tetranychus urticae*) INFESTING OKRA

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ABSTRACT

The research pertaining to red spider mite (*T. urticae*) in okra was carried out at the experimental field, Department of Plant Pathology, College of Agriculture, JAU, Junagadh, during 2023-24 and 2024-25. Ten okra varieties (GO-2, GO-6, VRO-6, GJO-3, Arka Abhay, Arka Anamika, JOL-20-4, JOL-21-02, JOL-21-08 and Pusa Savani) were randomly arranged. Substantial genotypic variation in mite infestation was evident across the evaluated entries. During 2024, Arka Anamika recorded the lowest mite incidence (6.99 mites /3.5 cm^2 leaf area), whereas Pusa Sawani exhibited the highest population (15.10 mites /3.5 cm^2 leaf area). In 2025, Arka Anamika again manifested minimum infestation (8.06 mites /3.5 cm^2 leaf area), while Pusa Sawani registered maximum infestation (17.13 mites /3.5 cm^2 leaf area). Pooled analysis revealed the lowest mite abundance in Arka Anamika (8.06 mites /3.5 cm^2 leaf area), whereas Pusa Sawani (16.05 mites /3.5 cm^2 leaf area) and GO-6 (14.94 mites /3.5 cm^2 leaf area) harboured elevated populations. Based on varietal categorization, Arka Anamika (7.47) and GO-2 (8.20) exhibited resistant reactions characterized by restricted colonization and reduced pest establishment. Conversely, Pusa Sawani (16.05) displayed a susceptible response with pronounced infestation intensity, indicating its vulnerability to mite attack.

Keywords **:** Red spider mite, *T. urticae*, genotypes, categorization.

Introduction

Okra (*Abelmoschus esculentus* L. Moench) is an important vegetable crop belonging to the Malvaceae family with 130 chromosomes (2n = 130). It originated in East Africa and is widely cultivated in tropical, subtropical and warm temperate regions of the world. The crop is vulnerable to attack by numerous insect and mite pests throughout its growth period, leading to considerable yield reduction. About 72 pest species have been reported infesting okra, among which several are of economic importance (Kedar *et al*., 2014). In India, the two-spotted red spider mite, *T. urticae* (Acarina: Tetranychidae), is considered one of the major pests of okra (Prasad, 1974). Commonly known as the red spider mite, it causes serious damage under favourable environmental conditions. The first report of the two-spotted red carmine spider mite on Ashwagandha (*Withania somnifera*) was documented from Amritsar, Punjab (Sharma and Pati, 2012). Host plant resistance is recognized as a sustainable and eco-friendly approach to pest management. Resistant cultivars provide effective protection against pest attack without increasing cultivation costs. Such varieties reduce crop losses, decrease pesticide dependence and support environmentally sound agriculture. Therefore, the development and adoption of resistant genotypes are regarded as an economical and efficient strategy for insect pest management (Siddhapara *et al*., 2018).

Materials and Methods

The experiment was conducted at the experimental farm, Department of Plant Pathology, JAU, Junagadh, during the summers of 2023-24 and 2024-25. Ten okra varieties (GO-2, GO-6, VRO-6, GJO-3, Arka Abhay, Arka Anamika, JOL-20-4, JOL-21-02, JOL-21-08 and

Pusa Savani) were evaluated in a Randomized Block Design (RBD) with three replications at a spacing of 60 × 30 cm. Recommended agronomic practices were followed and no pesticides were applied throughout the crop season. Ten plants from each plot were randomly selected and tagged for observation.

Categorization of varieties for red spider mites

Red spider mite population

The observations on mite population were recorded from a 3.5 cm^2 area of three leaves from the upper, middle and lower portions of each plant at weekly intervals. The data thus obtained were analyzed to assess the least susceptible genotype against the mites on okra.

Table 1: Scales used for categorization of different varieties of okra

Category of resistance	Scale for resistance
Highly Resistant	$\overline{X}_i \leq (\overline{X} - 2SD)$
Resistant	$\overline{X}_i > (\overline{X} - 2SD) < (\overline{X} - SD)$
Moderately Resistant	$\overline{X}_i > (\overline{X} - SD) < \overline{X}$
Moderately Susceptible	$\overline{X}_i > \overline{X} < (\overline{X} + SD)$
Susceptible	$\overline{X}_i > (\overline{X} + SD) < (\overline{X} + 2SD)$
Highly Susceptible	$\overline{X}_i \geq (\overline{X} + 2SD)$

To differentiate the mite infestation into different ten varieties, an attempt was made into different categories. Different okra cultivars were grouped into six categories of resistance to mite, *viz*., highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible based on no. of red spider mite/three leaves. For this purpose, the mean value of individual variety ($\overline{X}_i$) was compared with the mean value of all varieties ($\overline{X}$) and the standard deviation (SD) following the scale that is fit for the okra crop. The scale was used for categorizing different varieties as follows.

Result and Discussion

The experiment of varietal response in okra against red spider mite was established during the summer 2024 and 2025. The onset of mite infestation was frequently examined 2nd FAG in both years. Weekly observation on population were documented in Appendix A and B. Adequate variation in infestation intensity was observed among the varieties. Data were pooled over years to minimize seasonal fluctuations and that was based on varietal comparison summarized in Table 2 and Figure 1.

Year- 2024

The incidence of red spider mite among okra cultivars during 2024 was presented in Appendix A. Arka Anamika recorded the lowest infestation (6.99 mites /3.5 cm^2 leaf area) and remained statistically at par with GO-2 (7.82 mites /3.5 cm^2 leaf area), indicating superior resistance. The highest mite population was observed in Pusa Sawani (15.10 mites /3.5 cm^2 leaf area), followed by GO-6 (13.99 mites /3.5 cm^2 leaf area). Intermediate infestation levels were documented in Arka Abhay (9.50 mites /3.5 cm^2 leaf area), VRO-6 (11.31 mites /3.5 cm^2 leaf area) and GJO-3 (11.36 mites /3.5 cm^2 leaf area). Moderate mite densities were recorded in JOL-20-04 (11.67 mites /3.5 cm^2 leaf area), JOL-21-08 (12.87 mites /3.5 cm^2 leaf area) and JOL-21-02 (13.46 mites /3.5 cm^2 leaf area).

Year- 2025

The prevalence of red spider mite across the evaluated okra genotypes during 2025 was delineated in Appendix B. Arka Anamika manifested the lowest infestation level (8.06 mites /3.5 cm^2 leaf area), remaining statistically comparable with GO-2 (8.79 mites /3.5 cm^2 leaf area), thereby indicating a resistant response against mite colonization. In contrast, Pusa Sawani harboured the highest mite burden (17.13 mites /3.5 cm^2 leaf area), denoting pronounced susceptibility. Furthermore, Arka Abhay (10.39 mites /3.5 cm^2 leaf area) and VRO-6 (11.14 mites /3.5 cm^2 leaf area) exhibited relatively moderate infestation intensity. JOL-20-04 (12.01 mites /3.5 cm^2 leaf area), JOL-21-08 (12.44 mites /3.5 cm^2 leaf area) and JOL-21-02 (13.08 mites /3.5 cm^2 leaf area) sustained appreciable mite density, while GO-6 (15.41 mites /3.5 cm^2 leaf area) demonstrated a marked escalation in abundance.

Pooled over periods over year

Under pooled analysis over both years (2024 and 2025), certified from Table 2, the lines of okra verified the pronounced differences in mite population. The least infestation was evident in Arka Anamika (7.47 mites /3.5 cm^2 leaf area), Afterwards, GO-2 (8.20 mites /3.5 cm^2 leaf area) and Arka Abhay (9.96 mites /3.5 cm^2 leaf area), each were differed from one another. VRO-6 (11.21 mites /3.5 cm^2 leaf area) and GJO-3 (11.57 mites /3.5 cm^2 leaf area) represented an intermediate infestation. JOL-20-04 (11.77 mites /3.5 cm^2 leaf area), JOL-21-08 (12.64 mites /3.5 cm^2 leaf area) and JOL-21-02 (13.26 mites /3.5 cm^2 leaf area) showed raise in population of mite, while the highest population was recorded in Pusa Sawani (16.05 mites /3.5 cm^2 leaf area) followed by GO-6 (14.94 mites /3.5 cm^2 leaf area).

Table 2 : Comparative incidence of red spider mite on varieties of okra (Pooled over periods over year)

Varieties	Population of red spider mite		
	2024	2025	Pooled over periods over year
GO-2	2.80^{a} (7.82)	2.96^{a} (8.79)	2.86^{a} (8.20)
GO-6	3.81^{ef} (14.52)	3.93^{f} (15.41)	3.87^{f} (14.94)
VRO-6	3.36^{c} (11.31)	3.34^{bc} (11.14)	3.35^{c} (11.21)
GJO-3	3.37^{c} (11.36)	3.43^{cd} (11.80)	3.40^{c} (11.57)
Arka Abhay	3.08^{b} (9.50)	3.22^{b} (10.39)	3.16^{b} (9.96)
Arka Anamika	2.64^{a} (6.99)	2.84^{a} (8.06)	2.73^{a} (7.47)
JOL-20-04	3.42^{c} (11.67)	3.47^{cd} (12.01)	3.43^{cd} (11.77)
JOL-21-02	3.67^{de} (13.46)	3.62^{e} (13.08)	3.64^{e} (13.26)
JOL-21-08	3.59^{d} (12.87)	3.53^{de} (12.44)	3.56^{de} (12.64)
Pusa Sawani	3.89^{f} (15.10)	4.14^{g} (17.13)	4.01^{f} (16.05)
ANOVA			
S. Em. ± V	0.05	0.05	0.04
P	0.04	0.03	0.03
Y	-	-	0.06
V × P	0.18	0.19	0.19
V × Y	-	-	0.12
P × Y	-	-	0.02
V × P × Y	-	-	0.18
C. D. at 5% ± V	0.15	0.15	0.16
P	0.10	0.09	0.09
Y	-	-	0.15
V × P	0.53	0.55	NS
V × Y	-	-	0.33
P × Y	-	-	0.06
V × P × Y	-	-	NS
C. V.%	9.79	9.38	9.56

Note:1) Treatments means with letter(s) in common were significant at 5%

2) Figure in parentheses () were retransformed values; those outside were square root transformed value

Categorization of Okra Varieties /Cultivars in Relation to Red Spider Mite Infestation During 2024 and 2025

A comprehensive resistance stratification was undertaken to group the 10 okra cultivars into six categories of response against red spider mite *viz.*, highly resistant (HR), resistant (R), moderately resistant (MR), moderately susceptible (MS), susceptible (S) and highly susceptible (HS). The categorization was determined by no. of red spider mite per 3.5 cm^2 leaf area in relation to the no. of red spider mite per individual variety ($\overline{X}_i$) with the no. of all varieties ($\overline{X}$) and (SD), which was dispended in Table 3. Regarding the mite population perceived over a period, none of varieties /cultivars were categorized as highly resistant or highly susceptible.

Table 3 : Categorization of okra varieties /cultivars in relation to red spider mite population

Category of Resistance	Scale	Varieties /cultivars ($\overline{X}_i$)
Mite population: $\overline{X}$ = 11.71, SD = 2.57		
Highly Resistant (HR)	$\overline{X}_i \leq 6.56$	-
Resistant (R)	$9.14 \geq \overline{X}_i > 6.56$	GO-2 (8.20) Arka Anamika (7.47)
Moderately Resistant (MR)	$11.71 \geq \overline{X}_i > 9.14$	VRO-6 (11.21) GJO-3 (11.57) Arka Abhay (9.96)
Moderately Susceptible (MS)	$14.28 < \overline{X}_i \leq 11.71$	JOL-20-04 (11.77) JOL-21-08 (12.64) JOL-21-02 (13.26)
Susceptible (S)	$16.85 < \overline{X}_i \leq 14.28$	GO-6 (14.94) Pusa Sawani (16.05)
Highly Susceptible (HS)	$\overline{X}_i > 16.85$	-

Note: Figure in parentheses were red spider mite / 3.5 cm^2 leaf are on okra, mean no. of red spider mites per individual variety ($\overline{X}_i$), mean no. of all varieties ($\overline{X}$) and standard deviation (SD)

The least red spider mite population was demonstrated on Arka Anamika (7.47) and GO-2 (8.20), which exhibited a resistant response characterized by limited mite establishment. A moderate population intensity was proclaimed on VRO-6 (11.21), GJO-3 (11.57) and Arka Abhay (9.96) reflected the moderately resistant strains. Relatively higher mite population were sustained by JOL-20-04 (11.77), JOL-21-08 (12.64) and JOL-21-02 (13.26), corresponding to a moderately susceptible response. Comparatively higher population was conceived from GO-6 (14.94), while the highest infestation was confirmed in Pusa Sawani (16.05) indicated a susceptible reaction with pronounced infestation severity.

Patterns were observed during the study mirror findings of Vadher *et al*. (2025) who concluded that the minimum mite was recorded on GAO-5 (0.70 mite /2 cm^2 leaf area), whereas the maximum infestation noted in Pusa Sawani (7.48 mite /2 cm^2 leaf area). Based on resistance classification GAO-5 (0.70 mite /2 cm^2 leaf area) exhibited a highly resistant, while GO-2 was categorized as resistant to mite. In contradiction to this, JOL-14-10 (6.06 mite /2 cm^2 leaf area), Pusa Sawani (7.48 mite /2 cm^2 leaf area) and JOL-20-05 (6.31 mite /2 cm^2 leaf area) were grouped under susceptible entries.

Conclusion

Based on the categorization of okra varieties according to their reaction to red spider mite infestation, Arka Anamika and GO-2 exhibited the lowest mite population and were classified as resistant varieties. In contradiction to this, Pusa Sawani and GO-6 recorded the highest infestation and were categorized as susceptible varieties. The varieties VRO-6, GJO-3 and Arka Abhay demonstrated moderate resistance, indicating comparatively lower susceptibility to mite attack. Conversely, JOL-20-04, JOL-21-08 and JOL-21-02 were placed in the moderately susceptible category due to their intermediate mite infestation. These findings indicated the existence of considerable variability among the tested okra genotypes in their response to red spider mite infestation, highlighted the potential of resistant varieties as valuable genetic resources for the development of integrated pest management strategies and host plant resistance breeding programs.

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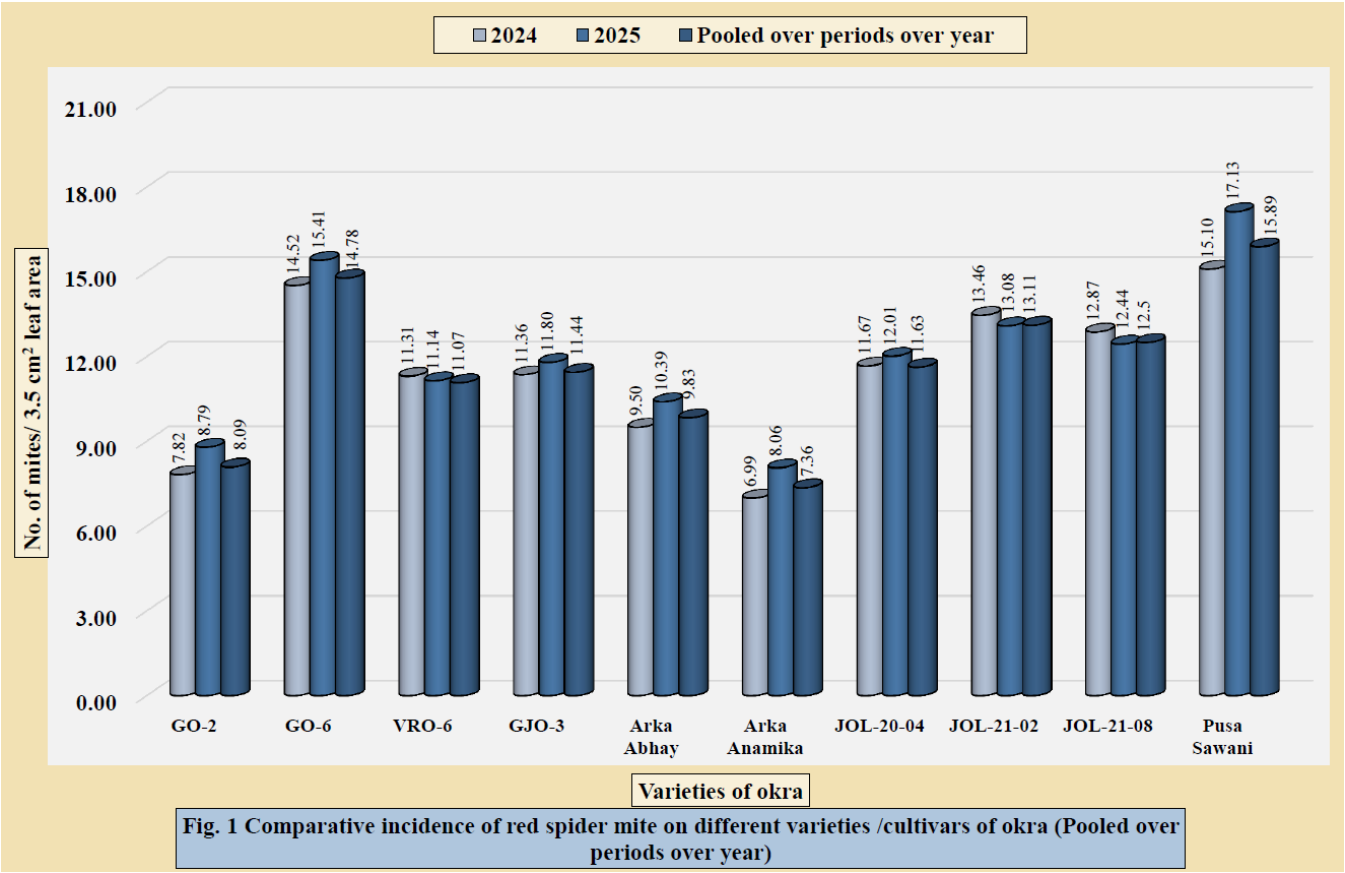

Fig. 1 Comparative incidence of red spider mite on different varieties /cultivars of okra (Pooled over periods over year)

Appendix A : Incidence of red spider mite weekly on varieties of okra during summer 2024

Sr. No.	Varieties	Mean mite infestation / 3.5 cm^2 leaf area at different SMW												Pooled
		March		April				May					June	
		12	13	14	15	16	17	18	19	20	21	22	23	
1	GO-2	2.17 (4.71)	2.42 (5.83)	2.65 (7.02)	2.62 (6.88)	2.64 (6.94)	2.80 (7.84)	2.98 (8.86)	3.26 (10.63)	3.10 (9.64)	3.08 (9.47)	2.96 (8.78)	2.68 (7.19)	2.80 (7.82)
2	GO-6	3.20 (10.21)	3.50 (12.23)	3.71 (13.76)	3.73 (13.89)	3.91 (15.27)	3.98 (15.87)	4.23 (17.92)	4.29 (18.39)	4.11 (16.88)	3.88 (15.08)	3.77 (14.25)	3.23 (10.44)	3.81 (14.52)
3	VRO-6	2.67 (7.14)	3.08 (9.48)	3.18 (10.09)	3.24 (10.48)	3.46 (11.96)	3.47 (12.02)	3.52 (12.38)	3.70 (13.70)	3.63 (13.18)	3.58 (12.81)	3.45 (11.90)	3.25 (10.55)	3.36 (11.31)
4	GJO-3	2.97 (8.85)	3.34 (11.15)	3.40 (11.58)	3.50 (12.28)	3.55 (12.59)	3.56 (12.64)	3.58 (12.83)	3.73 (13.88)	3.62 (13.07)	3.17 (10.06)	3.04 (9.23)	2.86 (8.16)	3.37 (11.36)
5	Arka Abhay	2.64 (6.96)	2.95 (8.72)	2.98 (8.86)	3.15 (9.95)	3.21 (10.33)	3.19 (10.18)	3.19 (10.22)	3.30 (10.91)	3.23 (10.45)	3.19 (10.17)	3.13 (9.79)	2.72 (7.42)	3.08 (9.50)
6	Arka Anamika	2.09 (4.38)	2.31 (5.33)	2.36 (5.57)	2.56 (6.56)	2.74 (7.49)	3.00 (8.98)	3.02 (9.13)	3.14 (9.89)	2.84 (8.04)	2.70 (7.26)	2.45 (6.02)	2.29 (5.25)	2.64 (6.99)
7	JOL-20-04	2.93 (8.60)	3.28 (10.77)	3.31 (10.96)	3.41 (11.66)	3.49 (12.16)	3.57 (12.75)	3.63 (13.20)	3.71 (13.78)	3.55 (12.63)	3.51 (12.34)	3.41 (11.63)	3.09 (9.53)	3.42 (11.67)
8	JOL-21-02	3.08 (9.46)	3.43 (11.74)	3.60 (12.94)	3.69 (13.59)	3.77 (14.19)	3.83 (14.70)	3.90 (15.19)	4.12 (16.97)	3.93 (15.41)	3.85 (14.80)	3.51 (12.35)	3.19 (10.16)	3.67 (13.46)
9	JOL-21-08	3.02 (9.15)	3.37 (11.38)	3.53 (12.46)	3.72 (13.82)	3.64 (13.23)	3.67 (13.47)	3.83 (14.67)	3.96 (15.69)	3.79 (14.34)	3.74 (14.00)	3.55 (12.63)	3.11 (9.66)	3.59 (12.87)
10	Pusa Sawani	3.30 (10.87)	3.69 (13.64)	3.74 (13.98)	3.78 (14.30)	3.95 (15.59)	4.04 (16.30)	4.34 (18.85)	4.39 (19.26)	4.17 (17.43)	3.91 (15.29)	3.84 (14.72)	3.30 (10.91)	3.89 (15.10)
S. Em. ±		0.14	0.17	0.18	0.18	0.18	0.21	0.21	0.22	0.22	0.21	0.18	0.19	0.05
C. D. at 5%		0.41	0.50	0.54	0.54	0.53	0.62	0.61	0.65	0.66	0.62	0.53	0.56	0.15
C. V. %		8.43	9.09	10.04	10.23	9.66	9.72	10.41	10.31	8.22	8.89	8.64	9.44	9.75

Notes: Figures outside the parentheses are $\sqrt{X}$ transformed values and those inside are retransformed values

Appendix B : Incidence of red spider mite weekly on varieties of okra during summer 2025

Sr. No.	Varieties	Mean mite infestation / 3.5 cm^2 leaf area at different SMW												Pooled
		March				April					May			
		10	11	12	13	14	15	16	17	18	19	20	21	
1	GO-2	2.77 (7.65)	2.87 (8.22)	2.91 (8.46)	2.94 (8.63)	2.98 (8.88)	3.03 (9.19)	3.08 (9.50)	3.19 (10.17)	3.09 (9.55)	3.00 (9.00)	2.92 (8.51)	2.77 (7.69)	2.96 (8.79)
2	GO-6	3.44 (11.86)	3.69 (13.60)	3.71 (10.76)	3.83 (14.70)	3.99 (15.94)	4.12 (16.97)	4.22 (17.80)	4.34 (18.85)	4.18 (17.46)	4.11 (16.88)	3.94 (15.49)	3.40 (11.56)	3.93 (15.41)
3	VRO-6	2.85 (8.14)	3.10 (9.61)	3.22 (10.36)	3.26 (10.60)	3.46 (11.96)	3.49 (12.18)	3.53 (12.46)	3.57 (12.72)	3.52 (12.36)	3.44 (11.81)	3.41 (11.65)	3.13 (9.81)	3.34 (11.14)
4	GJO-3	3.13 (9.81)	3.25 (10.55)	3.28 (10.74)	3.35 (11.19)	3.39 (11.49)	3.61 (13.00)	3.70 (13.67)	3.78 (14.26)	3.65 (13.30)	3.58 (12.83)	3.28 (10.77)	3.15 (9.93)	3.43 (11.80)
5	Arka Abhay	2.80 (7.86)	3.08 (9.47)	3.14 (9.86)	3.23 (10.45)	3.25 (10.59)	3.27 (10.68)	3.42 (11.71)	3.45 (11.90)	3.36 (11.28)	3.30 (10.90)	3.21 (10.33)	3.11 (9.70)	3.22 (10.39)
6	Arka Anamika	2.52 (6.34)	2.70 (7.270	2.73 (7.48)	2.78 (7.74)	2.86 (8.16)	2.93 (8.58)	2.99 (8.95)	3.14 (9.83)	3.02 (9.13)	2.98 (8.91)	2.79 (7.81)	2.56 (6.54)	2.84 (8.06)
7	JOL-20-04	3.07 (9.44)	3.16 (9.99)	3.23 (10.43)	3.31 (10.94)	3.56 (12.64)	3.72 (13.86)	3.77 (14.24)	3.90 (15.22)	3.77 (14.19)	3.67 (13.49)	3.19 (10.16)	3.09 (9.57)	3.47 (12.01)
8	JOL-21-02	3.25 (10.57)	3.29 (10.84)	3.36 (11.27)	3.56 (12.69)	3.71 (13.77)	3.83 (14.66)	3.87 (15.00)	3.95 (15.64)	3.79 (14.37)	3.77 (14.22)	3.70 (13.69)	3.21 (10.29)	3.62 (13.08)
9	JOL-21-08	3.21 (10.32)	3.26 (10.61)	3.30 (10.88)	3.38 (11.45)	3.56 (12.68)	3.71 (13.79)	3.73 (13.94)	3.77 (14.23)	3.70 (13.69)	3.72 (13.86)	3.69 (13.63)	3.20 (10.21)	3.53 (12.44)
10	Pusa Sawani	3.49 (12.19)	3.93 (15.45)	4.12 (16.97)	4.23 (17.90)	4.29 (18.43)	4.43 (19.62)	4.44 (19.69)	4.45 (19.80)	4.44 (19.68)	4.20 (17.61)	3.99 (15.96)	3.51 (12.290	4.14 (17.13)
S. Em. ±		0.15	0.16	0.17	0.20	0.21	0.20	0.21	0.22	0.23	0.20	0.18	0.18	0.05
C. D. at 5%		0.43	0.47	0.50	0.59	62	0.60	0.63	0.66	0.68	0.65	0.53	0.54	0.15
C. V. %		10.23	10.43	9.88	9.56	9.74	9.33	8.66	8.42	9.16	9.68	10.05	9.92	9.38

Notes: Figures outside the parentheses are $\sqrt{X}$ transformed values and those inside are retransformed values