



# **Evaluation of Okra Varieties under Sub-humid Plains of South-East Rajasthan for Morphological and Phenological Traits**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

## **Article Information**

DOI: 10.9734/ARJA/2024/v17i1409

## **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/112935>

**Original Research Article**

**Received: 10/12/2023**

**Accepted: 15/02/2024**

**Published: 19/02/2024**

## **ABSTRACT**

Vegetable crop okra is well known for its Indian vegetable export and household consumption, contribution and thus should be explored for cultivation under various agro climatic zones. Enhanced production of this crop is only possible via improved and high yielding cultivars in comparison to other cultivars grown at same time or under same condition. Hadoti region of South-East Rajasthan, can serve a okra production in better way if the productive varieties can be screened for this region, which is lacking till date. Hence an experiment is made to recommend a variety, which performs better under South-East climatic conditions of Rajasthan. The present study was conducted in the summer season during 2022 and 2023 at the Instructional Farm, Department of Horticulture, School of Agricultural Sciences, Career Point University, Kota, Rajasthan. 12 varieties of okra viz. Parbhani Kranti, Parbhani Bhindi, Arka Anamika, Shahiba, Shan, No. 55, Harita, Jhilmil, No. 64, Sonal, Shakti, and Punjab Selection were evaluated in Randomized Block Design, with three replication. Analysis of variance revealed that all varieties differed significantly for

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all the traits. The results concluded that, variation for earliness, growth, yield and quality parameters as well. These results showed presence of significant varietal effect. However, the present study demonstrated the superiority of Arka Anamika over other varieties in terms of maximum mean plant height (89.07 cm), number of leaves per plant (25.64), number of branches per plant (13.88), leaf length (19.03 cm), leaf width (25.32 cm) and leaf area (250.04 cm<sup>2</sup>) while minimum mean days taken to flowering opening to fruit picking (5.51 DAS) and days taken to first picking (47.16 DAS) was recorded in variety Punjab Selection under soil and climatic condition of Hadoti region of Rajasthan.

*Keywords: Evaluation; flowering; growth; varieties.*

## 1. INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] a prominent position among vegetables. Okra is known by many local names in different parts of the world. It is called lady's finger in England, Gumbo in U.S.A. and Bhindi in India. In India, it is one of the most important vegetable crop grown for its tender green fruits during summer and rainy seasons. It is a short duration crop propagated through seeds, cherished for its tender and scrumptious green fruits used in curries, soups or in canned, dehydrated or frozen forms for off-season consumption [1]. Okra is more remunerative as compared to the leafy vegetables. The roots and stems are useful for clearing cane juice from which gur or jaggery is prepared [2]. Its ripe seeds are roasted, ground and used as a substitute for coffee in Turkey [3].

The foremost challenges faced by okra crop is damage by many species of insect-pests and diseases throughout its growth period. Among these, jassid, fruit and shoot borer, powdery mildew and yellow vein mosaic are quite serious factors in okra cultivation. The challenge to the existence of mankind has always been to produce adequate quantity of food from the available acreage to meet the requirements of ever expanding world population. The rate of yield gain in crop improvement programme must match the rate of population growth so, as to avoid malnutrition and hunger. A lot of okra hybrids/varieties are being grown by the farmers, but best performing hybrids/varieties of okra having desirable quantitative and qualitative characters such as adoptability to adverse environments and resistance to biotic and a biotic stresses resulting into better monetary return to the vegetable growers. Keeping in view, it is essential to work out on the appropriate quantitative and qualitative characters of okra crop so that maximum yield and high-quality produce could be obtained. This is common fact that the varieties showing better performance

under one locality may not be suitable for another locality or region. So that the main aim of experiment is to find out the better performance of a particular okra variety in Hadoti region of Rajasthan and screen out to which variety well adopted and produced maximum yield to another variety under South-East region of Rajasthan.

## 2. MATERIALS AND METHODS

### 2.1 Location

Kota district is located at 25.18° N to 75.83° E Latitude in South Eastern Rajasthan. It covers an area of 221.36 km<sup>2</sup>. Agro-climatically, the district falls in Zone V, known as Humid South Eastern Plain. The average rainfall in the region is 660.6 mm. Maximum temperature range in the summer is 40 to 48°C and minimum 1.0- 2.6°C during winter. Major *kharif* crops of the district are soybean, maize and pulses. While in *rabi*, wheat, mustard, coriander and garlic are main crops.

### 2.2 Experimental Details

The present study was carried out at the Department of Horticulture, School of Agricultural Sciences, Career Point University, Kota (Rajasthan) during the year 2022 and 2023. Twelve varieties of okra viz. Parbhani Kranti, Parbhani Bhindi, Arka Anamika, Shahiba, Shan, No. 55, Harita, Jhilmil, No. 64, Sonal, Shakti, and Punjab Selection were evaluated in randomized block design, replicated thrice. Raised bed planting system at 60 x 30 cm spacing was adapted to grow the crop. The FYM 20 tonnes and RDF 150:100:100 NPK applied per hectare respectively, as basal dose.

### 2.3 Measurement of the Morphological Parameters

The morphological data such as, plant height was taken from the tagged plant in each replication with the help of a meter scale, total

number of leaves were counted from tagged plants in each replication after completion of harvesting period and expressed as average number of leaves per plant, number of branches of selected plants was counted and average was worked out, length of leaf and width was measured from randomly selected five leaves from every genotype with the help of scale and then average was recorded, leaf area of random five plants from each treatment was recorded by using electronic leaf area meter. The all plant morphological parameters was recorded at 30, 60 and 90 days after sowing the crop.

### 2.4 Measurement of the Phenological Parameters

Days taken to 50% flowering was recorded after sowing the crop when 5-6 plants in each replication started to flower and average number of days from sowing date was calculated to make the observation. The number of days taken to first picking was recorded from sowing date

was calculated to make the observation. Number of days required from the date of sowing to first picking of fruits was recorded.

## 3. RESULTS

### 3.1 Morphological Parameters

Data observed on morphological parameters showed that there was considerable variation among the all varieties during all the stage of plant growth. Among the different varieties the maximum mean plant height (89.07 cm), number of leaves per plant (25.64), number of branches per plant (13.88), leaf length (19.03 cm), leaf width (25.32 cm) and leaf area (250.04 cm<sup>2</sup>) was found superior in variety Arka Anamika. However, lowest plant height (64.39 cm), number of leaves per plant (18.24) and number of branches per plant (10.22) was recorded in Shan variety. The leaf length (13.97 cm), leaf width (19.54 cm) and leaf area (204.89 cm<sup>2</sup>) was found lowest in Punjab Selection variety 90 days after sowing (Tables 1 to 6).

**Table 1. Performance of different varieties of okra with respect to plant height**

Treatment	Varieties	Plant height (cm) 30 DAS			Plant height (cm) 60 DAS			Plant height (cm) 90 DAS		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T <sub>1</sub>	Parbhani Kranti	16.68	18.36	17.52	29.97	32.11	31.04	71.97	73.48	72.72
T <sub>2</sub>	Parbhani Bhindi	16.35	19.03	17.69	28.88	31.02	29.95	74.53	76.04	75.28
T <sub>3</sub>	Arka Anamika	19.43	22.11	20.77	38.17	40.31	39.24	88.32	89.83	89.07
T <sub>4</sub>	Shahiba	17.43	20.11	18.77	30.63	32.77	31.70	76.55	78.06	77.3
T <sub>5</sub>	Shan	16.03	18.71	17.37	27.03	29.17	28.10	63.64	65.15	64.39
T <sub>6</sub>	No. 55	16.46	19.21	17.83	28.41	30.55	29.48	68.30	69.81	69.05
T <sub>7</sub>	Harita	16.99	19.67	18.33	30.05	32.19	31.12	69.18	70.69	69.93
T <sub>8</sub>	Jhilmil	16.16	18.84	17.50	29.47	31.61	30.54	70.45	71.96	71.2
T <sub>9</sub>	No. 64	17.52	19.20	18.36	32.68	34.82	33.75	79.33	80.84	80.08
T <sub>10</sub>	Sonal	18.03	20.71	19.37	34.9	37.04	35.97	82.93	84.44	83.68
T <sub>11</sub>	Shakti	17.19	19.87	18.53	30.69	32.83	31.76	67.99	69.50	68.74
T <sub>12</sub>	Punjab Selection	15.90	18.58	17.24	29.03	31.17	30.10	71.01	72.52	71.76
	<b>SEm±</b>	<b>1.63</b>	<b>1.71</b>	<b>0.82</b>	<b>1.66</b>	<b>1.68</b>	<b>1.65</b>	<b>2.24</b>	<b>2.02</b>	<b>1.78</b>
	<b>C.D. (p = 0.05)</b>	<b>2.31</b>	<b>5.02</b>	<b>2.40</b>	<b>4.88</b>	<b>4.94</b>	<b>4.86</b>	<b>6.59</b>	<b>5.92</b>	<b>5.22</b>

**Table 2. Performance of different varieties of okra with respect to number of leaves per plant**

Treatment	Varieties	Number of Leaves 30 DAS			Number of Leaves 60 DAS			Number of Leaves 90 DAS		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T <sub>1</sub>	Parbhani Kranti	6.78	8.01	7.39	14.02	15.38	14.70	21.14	22.53	21.84
T <sub>2</sub>	Parbhani Bhindi	7.31	8.54	7.92	13.27	14.63	13.95	20.42	21.79	21.10
T <sub>3</sub>	Arka Anamika	8.84	10.07	9.45	17.38	16.06	18.06	24.94	26.33	25.64
T <sub>4</sub>	Shahiba	7.41	8.64	8.02	14.62	15.98	15.30	22.74	24.13	23.44
T <sub>5</sub>	Shan	6.84	8.07	7.45	12.40	13.76	13.08	17.54	18.93	18.24
T <sub>6</sub>	No. 55	7.18	8.41	7.79	13.39	14.75	14.07	21.10	22.49	21.80
T <sub>7</sub>	Harita	6.44	7.67	7.05	14.14	15.5	14.82	22.54	23.93	23.24
T <sub>8</sub>	Jhilmil	7.04	8.27	7.65	14.00	15.36	14.68	20.67	22.06	21.37
T <sub>9</sub>	No. 64	7.71	8.94	8.32	14.70	18.74	15.38	23.25	24.64	23.95
T <sub>10</sub>	Sonal	8.41	9.64	8.69	15.70	17.06	16.38	23.44	24.83	24.14
T <sub>11</sub>	Shakti	7.32	8.55	7.93	14.14	15.5	14.82	22.48	23.87	23.18
T <sub>12</sub>	Punjab Selection	6.58	7.81	7.19	14.92	16.28	15.60	20.3	21.69	21.00
	<b>SEm±</b>	<b>0.43</b>	<b>0.47</b>	<b>0.38</b>	<b>0.79</b>	<b>0.66</b>	<b>0.69</b>	<b>1.00</b>	<b>1.01</b>	<b>1.06</b>
	<b>C.D. (p = 0.05)</b>	<b>1.28</b>	<b>1.38</b>	<b>1.13</b>	<b>2.33</b>	<b>1.95</b>	<b>2.04</b>	<b>2.93</b>	<b>2.96</b>	<b>3.12</b>

### 3.2 Phenological Parameters

Data observed on phenological parameters showed that there was considerable variation in different varieties. The minimum mean days taken to 50% flowering was recorded in Shakti (43.15 DAS) whereas the maximum days taken to 50% flowering was found in Shan (47.28 DAS). Similarly, minimum mean days taken to

flowering opening to fruit picking was recorded in Punjab Selection (5.51 days) whereas the maximum days taken to flowering opening to fruit picking was found in Shan (9.51 days). However, minimum mean days taken to first picking was recorded in Punjab Selection (47.76 days) whereas the maximum days (54.02 days) taken to first picking was found in variety Shan (Table7).

**Table 3. Performance of different varieties of okra with respect to number of branches per plant**

Treatment	Varieties	Number of Branches 30 DAS			Number of Branches 60 DAS			Number of Branches 90 DAS		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T <sub>1</sub>	Parbhani Kranti	3.12	3.44	3.28	8.18	8.41	8.30	10.47	10.66	10.57
T <sub>2</sub>	Parbhani Bhindi	2.85	3.17	3.01	7.78	8.01	7.90	10.83	11.02	10.93
T <sub>3</sub>	Arka Anamika	3.85	4.17	4.01	8.68	8.91	8.80	13.78	13.97	13.88
T <sub>4</sub>	Shahiba	2.92	3.24	3.08	8.15	8.38	8.27	11.05	11.24	11.15
T <sub>5</sub>	Shan	3.25	3.57	3.41	6.98	7.21	7.10	10.12	10.31	10.22
T <sub>6</sub>	No. 55	3.38	3.70	3.54	7.84	8.07	7.96	10.88	11.07	10.98
T <sub>7</sub>	Harita	3.18	3.50	3.34	8.12	8.35	8.24	12.72	12.91	12.82
T <sub>8</sub>	Jhilmil	3.12	3.44	3.28	8.11	8.34	8.23	10.66	10.85	10.76
T <sub>9</sub>	No. 64	3.38	3.70	3.54	9.38	9.61	9.50	11.75	11.94	11.85
T <sub>10</sub>	Sonal	3.45	3.77	3.61	8.28	8.51	8.40	12.44	12.63	12.54
T <sub>11</sub>	Shakti	3.25	3.57	3.41	8.52	8.75	8.64	13.49	13.68	13.59
T <sub>12</sub>	Punjab Selection	3.32	3.64	3.48	8.65	8.88	8.77	13.12	13.31	13.22
	<b>SEm±</b>	<b>0.16</b>	<b>0.24</b>	<b>0.22</b>	<b>0.35</b>	<b>0.33</b>	<b>0.45</b>	<b>0.83</b>	<b>0.35</b>	<b>0.46</b>
	<b>C.D. (p = 0.05)</b>	<b>0.49</b>	<b>0.72</b>	<b>0.65</b>	<b>1.05</b>	<b>0.97</b>	<b>1.34</b>	<b>2.44</b>	<b>1.05</b>	<b>1.35</b>

**Table 4. Performance of different varieties of okra with respect to leaf length (cm) per plant**

Treatment	Varieties	Leaf length (cm) 30 DAS			Leaf length (cm) 60 DAS			Leaf length (cm) 90 DAS		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T <sub>1</sub>	Parbhani Kranti	8.13	8.45	8.29	14.80	15.05	14.92	16.19	16.49	16.34
T <sub>2</sub>	Parbhani Bhindi	8.33	8.65	8.49	14.00	14.25	14.12	16.30	16.60	16.45
T <sub>3</sub>	Arka Anamika	10.09	10.41	10.25	17.09	17.34	17.21	18.87	19.17	19.03
T <sub>4</sub>	Shahiba	9.14	9.46	9.30	14.94	15.19	15.06	16.61	16.91	16.76
T <sub>5</sub>	Shan	7.53	7.85	7.69	12.53	12.78	12.65	14.99	15.29	15.14
T <sub>6</sub>	No. 55	8.16	8.48	8.32	14.12	14.37	14.24	15.53	15.83	15.68
T <sub>7</sub>	Harita	8.99	9.31	9.15	13.80	14.05	13.92	16.28	16.58	16.44
T <sub>8</sub>	Jhilmil	8.82	9.14	8.98	12.94	13.19	13.06	15.83	16.13	15.98
T <sub>9</sub>	No. 64	9.40	9.72	9.56	15.26	15.51	15.38	16.91	17.21	17.06
T <sub>10</sub>	Sonal	9.81	10.13	9.97	16.08	16.33	16.20	17.47	17.77	17.62
T <sub>11</sub>	Shakti	8.48	8.80	8.64	12.70	12.95	12.82	15.02	15.32	15.17
T <sub>12</sub>	Punjab Selection	7.88	8.20	8.04	11.68	11.93	11.80	13.82	14.12	13.97
	<b>SEm±</b>	<b>0.50</b>	<b>0.44</b>	<b>0.50</b>	<b>0.71</b>	<b>0.47</b>	<b>0.59</b>	<b>0.83</b>	<b>0.45</b>	<b>0.58</b>
	<b>C.D. (p = 0.05)</b>	<b>1.46</b>	<b>1.31</b>	<b>1.44</b>	<b>2.10</b>	<b>1.39</b>	<b>1.72</b>	<b>2.44</b>	<b>1.32</b>	<b>1.69</b>

**Table 5. Performance of different varieties of okra with respect to leaf width (cm) per plant**

Treatment	Varieties	Leaf width (cm) 30 DAS			Leaf width (cm) 60 DAS			Leaf width (cm) 90 DAS		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T <sub>1</sub>	Parbhani Kranti	9.64	9.96	9.80	19.67	19.92	19.79	21.51	21.66	21.51
T <sub>2</sub>	Parbhani Bhindi	9.45	9.77	9.61	18.65	18.90	18.77	20.97	21.12	20.97
T <sub>3</sub>	Arka Anamika	12.10	12.42	12.26	22.59	22.84	22.71	25.32	25.47	25.32
T <sub>4</sub>	Shahiba	10.08	10.40	10.24	20.31	20.56	20.43	22.27	22.42	22.27
T <sub>5</sub>	Shan	8.51	8.83	8.67	16.97	17.22	17.09	18.75	18.9	18.75
T <sub>6</sub>	No. 55	9.01	9.33	9.17	18.52	18.77	18.64	20.14	20.29	20.14
T <sub>7</sub>	Harita	9.74	10.06	9.90	18.87	19.12	18.99	21.38	21.53	21.38
T <sub>8</sub>	Jhilmil	9.53	9.85	9.69	17.76	18.01	17.88	21.81	21.96	21.81
T <sub>9</sub>	No. 64	10.34	10.66	10.50	20.84	21.09	20.96	23.41	23.56	23.41
T <sub>10</sub>	Sonal	10.93	11.25	11.09	21.53	21.78	21.65	23.98	24.13	23.98
T <sub>11</sub>	Shakti	9.04	9.36	9.20	19.28	19.53	19.40	22.04	22.19	22.04
T <sub>12</sub>	Punjab Selection	8.11	8.43	8.27	16.84	17.09	16.96	19.54	19.69	19.54
	<b>SEm±</b>	<b>0.50</b>	<b>0.51</b>	<b>0.68</b>	<b>1.04</b>	<b>0.57</b>	<b>0.62</b>	<b>0.67</b>	<b>0.83</b>	<b>0.70</b>
	<b>C.D. (p = 0.05)</b>	<b>1.46</b>	<b>1.50</b>	<b>1.98</b>	<b>3.06</b>	<b>1.68</b>	<b>1.83</b>	<b>1.95</b>	<b>2.44</b>	<b>2.00</b>

**Table 6. Performance of different varieties of okra with respect to Leaf Area (cm<sup>2</sup>) per plant**

Treatment	Varieties	Leaf Area (cm <sup>2</sup> ) 30 DAS			Leaf Area (cm <sup>2</sup> ) 60 DAS			Leaf Area (cm <sup>2</sup> ) 90 DAS		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T <sub>1</sub>	Parbhani Kranti	149.14	150.46	149.80	184.37	186.29	185.33	220.96	223.92	222.44
T <sub>2</sub>	Parbhani Bhindi	156.27	157.59	156.93	191.39	193.31	192.35	226.05	229.01	227.53
T <sub>3</sub>	Arka Anamika	172.06	173.38	172.72	223.53	225.45	224.49	248.56	251.52	250.04
T <sub>4</sub>	Shahiba	161.96	163.28	162.62	199.28	201.20	200.24	230.63	233.59	232.11
T <sub>5</sub>	Shan	118.32	119.64	118.98	167.54	169.46	168.50	198.49	201.45	199.97
T <sub>6</sub>	No. 55	123.39	124.71	124.05	173.14	175.06	174.10	205.73	208.69	207.21
T <sub>7</sub>	Harita	134.60	135.92	135.26	177.46	179.38	178.42	211.61	214.57	213.09
T <sub>8</sub>	Jhilmil	144.10	145.42	144.76	179.65	181.57	180.61	216.07	219.03	217.55
T <sub>9</sub>	No. 64	164.57	165.89	165.23	208.69	210.61	209.65	235.07	238.03	236.55
T <sub>10</sub>	Sonal	168.72	170.04	169.38	217.32	219.24	218.28	240.18	243.14	241.66
T <sub>11</sub>	Shakti	137.38	138.70	138.04	191.26	193.18	192.22	204.56	207.52	206.04
T <sub>12</sub>	Punjab Selection	127.13	128.62	127.96	182.08	184.00	183.04	203.41	206.37	204.89
	<b>SEm±</b>	<b>2.21</b>	<b>2.24</b>	<b>2.55</b>	<b>2.41</b>	<b>2.47</b>	<b>2.55</b>	<b>1.66</b>	<b>2.41</b>	<b>1.90</b>
	<b>C.D. (p = 0.05)</b>	<b>6.51</b>	<b>6.60</b>	<b>7.49</b>	<b>7.06</b>	<b>7.21</b>	<b>7.50</b>	<b>4.88</b>	<b>7.06</b>	<b>5.50</b>

**Table 7. Performance of different varieties of okra with respect to phonological characteristics**

Treatment	Varieties	Days Taken to 50% Flowering			Days taken to flower opening to fruit picking			Days Taken to First Picking		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T <sub>1</sub>	Parbhani Kranti	44.39	43.07	43.73	7.66	7.36	7.51	51.47	49.55	50.51
T <sub>2</sub>	Parbhani Bhindi	46.66	45.34	46.00	8.66	8.36	8.51	52.58	50.66	51.62
T <sub>3</sub>	Arka Anamika	43.99	42.67	43.33	6.66	6.36	6.51	50.22	48.30	49.26
T <sub>4</sub>	Shahiba	44.79	43.47	44.13	7.04	6.74	6.89	50.87	48.95	49.91
T <sub>5</sub>	Shan	47.94	46.62	47.28	9.66	9.36	9.51	54.98	53.06	54.02
T <sub>6</sub>	No. 55	46.36	45.04	45.70	9.31	9.01	9.17	53.26	51.34	52.30
T <sub>7</sub>	Harita	44.97	43.65	44.31	7.93	7.63	7.78	51.45	49.53	50.49
T <sub>8</sub>	Jhilmil	45.42	44.10	44.76	7.33	7.03	7.19	51.52	49.60	50.56
T <sub>9</sub>	No. 64	45.83	44.51	45.17	6.87	6.57	6.72	52.08	50.16	51.12
T <sub>10</sub>	Sonal	43.99	42.67	43.34	6.64	6.34	6.49	51.37	49.45	50.41
T <sub>11</sub>	Shakti	44.15	42.49	43.15	5.92	5.62	5.77	49.49	47.57	48.53
T <sub>12</sub>	Punjab Selection	42.93	41.61	42.27	5.66	5.36	5.51	48.72	46.80	47.76
	<b>SEm±</b>	<b>0.80</b>	<b>0.83</b>	<b>0.67</b>	<b>0.61</b>	<b>0.33</b>	<b>0.62</b>	<b>1.09</b>	<b>1.67</b>	<b>0.62</b>
	<b>C.D. (p = 0.05)</b>	<b>2.35</b>	<b>2.44</b>	<b>1.95</b>	<b>1.80</b>	<b>0.98</b>	<b>1.83</b>	<b>3.20</b>	<b>4.89</b>	<b>0.89</b>

#### 4. DISCUSSION

It is clear from the experimental results that significant variations were recorded amongst the different varieties of okra for the studied on growth parameters viz. plant height, number of leaves per plant, number of branches per plant, leaf length, leaf width and leaf area.

The maximum mean plant height was recorded in “Arka Anamika” (89.07 cm) while the lowest plant height was found in “Shan” (64.39 cm). The significant differences amongst the varieties for plant height could be attributed to their genetic constitution and inheritance of the character as well as differences in apical dominance controlled by the endogenous auxin level of the genotypes. The obtained results are in accordance with earlier finding of Sharma et al. [4], Singh et al. [5] for plant height; Kandasamy et al. [6], Darshan et al. [7] and Deepanshu and Shamad [8].

The maximum mean numbers of branches per plant (13.88) and leaves per plant (25.64) were

found in ‘Arka Anamika’ while the minimum numbers of branches per plant (10.22) and leaves per plant (18.24) were found in ‘Shan’. The differences amongst the varieties and hybrids for number of branches per plant could be attributed to their differential endogenous auxin and cytokinin contents which regulate the lateral growth and bud development, as low auxin and higher cytokinin levels promote lateral growth and bud development or vice-versa. The variation in number of leaves per plant may be due to varying branching in plants. The findings are in agreement with the results of Deepanshu and Shamad [8], Simon et al. [9], Muluken et al. [10] and Kumar et al. [11] for number of branches per plant and Kumar et al. [12] for number of leaves per plant.

The maximum mean leaf length (19.03 cm) leaf width (25.32 cm) were found in ‘Arka Anamika’ while the minimum mean leaf length (10.22) and leaf width (19.54) were found in ‘Punjab Selection’. The differences amongst the different varieties for leaf length and leaf width could be attributed to their differential endogenous auxin

and cytokinin contents which regulate the lateral growth and bud development, as low auxin and higher cytokinin levels promote lateral growth and bud development or vice-versa. The variation in length and leaf width may be due to varying branching in plants. The findings are in agreement with the results of Deepanshu and Shamadm [8] and Kumar et al. [11] and Das et al. [13] for number of branches per plant and Kumar et al. [12] and Singh et al. [14] for number of leaves per plant.

The largest leaves (250.04 cm<sup>2</sup> area) were recorded in 'Arka Anamika' while the smallest leaves (204.89 cm<sup>2</sup> area) in 'Punjab Selection'. The variation in leaf area amongst the different varieties of okra might be due to their genetic makeup governing the nutrient uptake behaviour, photosynthetic efficiency and their environmental interactions. The observed results are in accordance to Chandramouli et al. [15] and Bendale et al. [16].

The flowering parameters viz. days taken to 50% flowering, days taken to flowering opening to fruit picking and days taken to first picking were significantly influenced by the different varieties of okra.

The minimum mean days taken to 50% flowering were recorded in 'Shakti' (43.15 DAS), while the most late 50% flowering were recorded in 'Shan' (47.28 DAS). Similarly minimum mean days taken to flowering opening to fruit picking was recorded in "Punjab Selection" (5.51 days) whereas the maximum mean days taken to flowering opening to fruit picking was found in "Shan" (9.51 days). On the other hand minimum mean days taken to first picking was recorded in "Punjab Selection" (47.76 days), whereas the maximum days taken to first picking was found in "Shan" (54.02 days). The early or late production of flowers by different varieties and hybrids of okra might have been genetically controlled and better adaptability to particular environmental conditions as supported by the earlier findings of Kandasamy et al. [6], Kumar et al. (2017), Duggi et al. [17], Chandra et al. [18], Kumar et al. [19] and Bagwale et al. [20] for days taken to 50 per cent flowering and Adeoluwa and Kehinde [21] for early flowering.

## 5. CONCLUSION

Based on the overall effects, the variety Arka Anamika was highest in terms of all growth characteristics but Punjab Selection was found earliness in flowering and fruiting. Hence, variety

Punjab Selection may be considered worth for better harvest of the crop under Hadoti region of South-East Rajasthan.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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