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Evaluation of Growth and Yield Parameters of Okra [*Abelmoschus esculentus* (L.) Moench] Genotypes under Temperate Conditions of Kashmir Valley

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ABSTRACT

The present study entitled "Evaluation of growth and yield parameters of okra [*Abelmoschus esculentus* (L.) Moench] genotypes under temperate conditions of Kashmir valley'' was conducted during *kharif* 2020, at the Experimental Field, Division of Vegetable Science, SKUAST-K, Shalimar. The design employed in the present study was Randomized Complete Block Design (RCBD) with twelve genotypes and three replications. The observations were recorded on fourteen quantitative traits viz., days to first flowering, days to first fruit harvest, days to last fruit harvest, plant height, number of nodes plant^{-1}, number of fruits plant^{-1}, fruit length, fruit girth, average fruit weight, number of ridges fruit^{-1}, fruit yield plant^{-1}, fruit yield plot^{-1}, number of seeds fruit^{-1} and 100 seed weight. The results demonstrated that all the genotypes exhibited significant variation in their performance in terms of growth and yield traits. Among the genotypes, IC-18530, Elephant Tusk and SK-BS-11 were found promising for most of the growth and yield-contributing traits under temperate conditions of Kashmir valley. These genotypes could be used further in hybrid breeding program, due to their superior performance for various traits.

Keywords Okra, Genotype, Growth, Yield, Quantitative traits.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench), also known as Lady's finger, is a member of the family Malvaceae and is grown as a summer and rainy season crop in India (Kanaujia *et al*. 2020) It is a Semi-woody, fibrous and herbaceous annual plant which originated probably from East Africa and today is widely distributed in the tropics, subtropics and warmer portions of the temperate region (Nosiru *et al*. 2012). The plant's edible part is the immature young seed pods, which are eaten as a cooked vegetable, generally fresh but sometimes sun-dried. In the genus

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Abelmoschus, significant variation in chromosome number and ploidy level has been reported in different species, however the most common observed chromosome number is 2n = 130 (Joshi and Hardas 1956). Okra is a self-pollinated crop, however 4 to 19 % cross pollination by insects has been reported (Choudhury and Choonsai 1970), resulting in significant genetic variation. Okra is classified as an often cross pollinated crop because self-pollination is more prevalent than cross pollination.

Vitamins and mineral salts, particularly calcium, are abundant in okra, which are usually lacking in the diets of developing countries. The nutritive value of okra pods per 100 g edible portion is water 88.6 g, energy 144.00 kJ (36 kcal), protein 2.10 g, carbohydrate 8.20 g, fat 0.20 g, fiber 1.70 g, Ca 84.00 mg, P 90.00 mg, Fe 1.20 mg, β-carotene 185.00 µg, riboflavin 0.08mg, thiamin 0.04 mg, niacin 0.60 mg, ascorbic acid 47.00 mg. Okra contains high amount of vitamins A and B, protein and minerals (Gemede *et al*. 2014). It is rich in iodine and is useful for curing goiter disease (Adams 1975). Dried fruit is utilized to obtain refined edible oil since it contains 13-22% edible oil and 20-24% protein. Dry fruit skin and fibeSrs are used in manufacture of paper, card board and fiber (Tripathi and Upadhyay 2017). The mucilaginous extract of okra is used to purify the sugarcane juice that is used to make jaggary or brown sugar (Prasad and Nath 2002).

The adoption of poor yielding local varieties, low plant density, and intense attack of insect pests, diseases, and weeds, among other factors, has a substantial impact on okra production and productivity. One of the most serious problems in okra production is the use of low-yielding cultivars, which results in lower productivity in India than in other countries, resulting in large yield losses. Higher crop yields can be attained by cultivating varieties or genotypes that produce significantly higher returns when compared to other cultivars grown in the same climate and with the same inputs. However, by carefully evaluating and selecting optimal okra genotypes based on region, productivity could be increased. Keeping these factors in view, the current study was designed with an objective to assess the growth and yield parameters of various okra genotypes.

MATERIALS AND METHODS

During the *kharif* season of 2020, the present study was conducted at the Vegetable Experimental Farm, Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar. The basic materials included twelve diverse okra genotypes (*Abelmoschus esculentus* L. Moench). With three replications, the experiment was set up in a Randomized Block Design. The data was recorded on fourteen quantitative characters viz., days to first flowering, days to first fruit harvest, days to last fruit harvest, plant height (cm), number of nodes plant^{-1}, number of fruits plant^{-1}, fruit length (cm), fruit girth (cm), average fruit weight (g), number of ridges fruit^{-1}, fruit yield plant^{-1} (kg), fruit yield plot^{-1} (kg), number of seeds fruit^{-1} and 100 seed weight (g) were recorded. Standard statistical approaches were used to analyse the data.

RESULTS AND DISCUSSION

Tables 1a and 1b show the mean performance of genotypes for growth and yield traits. The table shows that there is a sufficient amount of variation in the given collection of genotypes, indicating that there is a good chance of improving the population through various breeding procedures.

Among the genotypes, Parbhani Kranti was the earliest to flower, taking 57.44 days, followed by Arka Anamika (57.70 days) and SK-BS-11 (58.60 days). EC-306748 recorded highest number of days to first flowering (66.15). The genotypes' average number of days to first flowering was 61.6. Early flowering might be due to the better adaptability and genetic performance of the genotypes. For days to first fruit harvest, the lowest value was noted in Parbhani Kranti (62.13) followed by Hissar Unnat (63.37) and SK-BS-11 (63.47) while as highest value was recorded for EC-306748 (72.16). The genotypes' average number of days to first fruit harvest was 66.80. As per the analysis, it was found that Parbhani Kranti was an early variety which flowered and yielded the earliest while EC-306748 behaved the opposite and was found to be a late variety. For days to last fruit harvest, highest mean value was noted for genotype Elephant Tusk

Table 1a. Mean performance of maturity and yield attributing traits in okra (*Abelmoschus esculentus* L. Moench).

Sl. No.	Genotypes	Days to first flowering	Days to first fruit harvest	Days to last fruit harvest	Plant height (cm)	Number of nodes plant^{-1}	Number of fruits plant^{-1}	Fruit length (cm)
1.	Arka Anamika	57.70	63.51	158.89	143.05	29.50	32.70	9.28
2.	Parbhani Kranti	57.44	62.13	144.94	135.27	20.98	27.57	8.36
3.	Kashi Vardhana	60.49	65.38	142.63	129.39	19.81	24.10	8.84
4.	Pusa-A-4	61.88	67.08	149.85	136.64	24.03	23.30	6.88
5.	Elephant Tusk	60.82	66.38	159.91	186.87	31.79	38.27	11.11
6.	Hissar Unnat	60.19	63.37	144.01	133.14	20.87	24.00	8.15
7.	Kashi Kranti	65.19	70.26	153.35	130.04	19.91	24.84	6.57
8.	Okra -7-Lines	64.89	71.36	150.77	154.31	22.83	27.14	7.09
9.	IC-18530	60.64	66.61	157.06	194.89	29.94	35.28	9.54
10.	EC-306748	66.15	72.16	151.90	184.74	25.90	28.39	9.01
11.	SK-BS-11	58.60	63.47	156.35	192.50	30.77	40.88	10.93
12.	Pusa Sawani	65.21	69.94	155.10	169.15	27.76	35.09	9.03
	CD at 5%	0.806	0.848	0.983	1.759	1.684	2.032	0.591

(159.91) followed by Arka Anamika (158.89) and IC-18530 (157.06) while as lowest mean value was noted for Vardhana (142.63). The genotypes' average number of days to last fruit harvest was 152.06.

IC-18530 had the highest value for plant height (194.89 cm) followed by SK-BS-11 (192.50 cm) and Elephant Tusk (186.87 cm) while as lowest value was recorded for Vardhana (129.39 cm). All genotypes had an average plant height of 157.49 cm. The reasons for increase in plant height might be due to longer intermodal length in tall genotype or due to specific genetic make-up of the different genotypes.

For number of nodes plant^{-1}, Elephant Tusk had the highest value (31.79) followed by SK-BS-11 (30.77) and IC-18530 (29.94) while as lowest value was recorded for Kashi Vardhana (19.81). All the genotypes had an average of 25.34 nodes plant^{-1}. The genotypes having greater plant height also showed more number of nodes. The average number of fruits plant^{-1} was 30.13 across all genotypes. SK-BS-11 had the highest value for number of fruits plant^{-1} (40.88) followed by Elephant Tusk (38.27) and IC-18530 (35.28) while as lowest value was recorded for Pusa-A-4 (23.30). The data supports the fact that more the number of nodes, more shall be the branches hence

Table 1b. Mean performance of maturity and yield attributing traits in okra (*Abelmoschus esculentus* L. Moench).

Sl. No.	Genotypes	Fruit girth (cm)	Average fruit weight (g)	Number of ridges fruit^{-1}	Fruit yield plant^{-1} (kg)	Fruit yield plot^{-1} (kg)	Number of seeds fruit^{-1}	100 seed weight (g)
1.	Arka Anamika	1.24	10.16	5.19	0.33	2.66	41.85	6.07
2.	Parbhani Kranti	1.15	6.68	5.13	0.19	1.56	45.80	5.15
3.	Kashi Vardhana	1.24	7.26	5.32	0.18	1.46	41.75	5.59
4.	Pusa-A-4	1.32	5.81	5.13	0.14	1.11	40.45	6.15
5.	Elephant Tusk	1.30	9.52	5.20	0.36	2.91	44.36	5.73
6.	Hissar Unnat	1.17	6.51	5.17	0.16	1.27	36.98	6.83
7.	Kashi Kranti	1.39	5.79	5.20	0.15	1.20	40.41	6.01
8.	Okra -7-Lines	1.22	6.44	5.26	0.18	1.44	44.34	5.53
9.	IC-18530	1.53	9.90	5.82	0.35	2.79	61.04	5.13
10.	EC-306748	1.40	7.65	5.93	0.22	1.78	63.44	4.62
11.	SK-BS-11	1.26	10.11	5.13	0.41	3.30	43.41	6.25
12.	Pusa Sawani	1.40	9.02	5.33	0.32	2.54	52.13	5.29
	CD at 5%	0.116	0.537	0.173	0.023	0.189	2.689	0.493

more the number of fruits.

Fruit length was found highest in the genotype Elephant Tusk (11.11 cm) followed by SK-BS-11 (10.93 cm) and IC-18530 (9.54 cm) while as lowest value was noted for Kashi Kranti (6.57 cm). All genotypes had an average fruit length of 8.73 cm. The highest value for fruit girth was noted in genotype IC-18530 (1.53 cm) followed by Pusa Sawani and EC-306748 (both 1.40 cm) while as lowest value was recorded for Parbhani Kranti (1.15 cm). All genotypes had an average fruit girth of 1.30 cm. The differences in genetic make-up of the okra genotypes and their response to the prevailing environmental conditions cause variation in fruit length and fruit girth.

All genotypes had an average fruit weight of 7.90 g. Highest value for average fruit weight was recorded for the genotype Arka Anamika (10.16 g) followed by SK-BS-11 (10.11 g) and IC-18530 (9.90 g) while as lowest value was recorded for Kashi Kranti (5.79 g). Average fruit weight also varied positively with the fruit length determining that the fruit weight is affected by the fruit length. Number of ridges fruit^{-1} was highest for the genotype EC-306748 (5.93) followed by IC-18530 (5.82) whereas lowest value for it was recorded for Pusa-A-4 and SK-BS-11 (5.133 both). All of the genotypes had an average of 5.32 ridges fruit^{-1}. The variation in number of ridges fruit^{-1} among various genotypes may be due to the genetic make-up of the genotype which influences the performance of a crop.

The genotype SK-BS-11 noted the maximum fruit yield plant^{-1} (0.41 kg) followed by Elephant Tusk (0.36 kg) and IC-18530 (0.35 kg) while as lowest value was noted in Pusa-A-4 (0.14 kg). The average fruit yield plant^{-1} was 2.99 kg across all genotypes. For fruit yield plot^{-1}, highest value was recorded in genotype SK-BS-11 (3.30 kg) followed by Elephant Tusk (2.91 kg) and IC-18530 (2.79 kg) whereas lowest value was recorded for Pusa-A-4 (1.11 kg). The average fruit yield plot^{-1} was 2.00 kg for all genotypes. Looking at the yield performance, it can be observed that the parameters like plant height, number of nodes plant^{-1}, fruit length, average fruit weight, number of fruits plant^{-1} were all contributing towards the yield in okra.

EC-306748 recorded the maximum number of seeds fruit^{-1} (63.44) followed by IC-18530 (61.04) and Pusa Sawani (52.13) while as lowest value was recorded for Hissar Unnat (36.98). The average number of seeds fruit^{-1} was 46.33 across all genotypes. The differences in the number of seeds per fruit between genotypes could be attributed to genetic differences. Highest value for 100 seed weight was noted for the genotype Hissar Unnat (6.83 g) followed by SK-BS-11 (6.25 g) and Pusa-A-4 (6.15 g) while as lowest value was recorded for EC-306748 (4.62 g). The average 100 seed weight of all the genotypes was 5.69 g. The genetic variation among genotypes and their interaction with the environment account for the difference in 100 seed weight.

Table 2 shows the best-performing genotypes in terms of many traits. It may be advantageous to select genotypes based on their *per se* performance. Genetic studies such as variability, heritability, genetic progress, correlation, and path analysis should be coupled with *per se* performance to improve the selection process. The mean performance of genotypes revealed that none of the genotypes outperformed the others for all of the traits. Variation in performance of okra genotypes for several parameters has also been found in a wide number of studies (Chaudhary *et al*. 2006, Jindal and Arora 2010, Sindhumole and Manju 2014, Meher *et al*. 2016, Prasad *et al*. 2016, Mishra *et al*. 2017, Rajesh *et al*. 2018, Singla *et al*. 2018, Jangde *et al*. 2019, Walling *et al*. 2020).

CONCLUSION

In the present study based on overall performance of genotypes revealed that IC-18530, Elephant Tusk and SK-BS-11 performed better for some important traits. IC-18530 was superior for plant height (194.89 cm), number of nodes plant^{-1} (29.94), number of fruits plant^{-1} (35.28), fruit length (9.54 cm), average fruit weight (9.90 g), fruit yield plant^{-1} (0.35 kg), fruit yield plot^{-1} (2.79 kg), number of seeds fruit^{-1} (61.04), Elephant Tusk was found superior for plant height (186.87 cm), number of nodes plant^{-1} (31.79), number of fruits plant^{-1} (38.27), fruit length (11.11 cm), fruit yield plant^{-1} (0.36 kg), fruit yield plot^{-1} (2.91 kg) and SK-BS-11 for plant height (192.50 cm), number of

Table 2. Best okra (*Abelmoschus esculentus* L. Moench) genotypes based on *per se* performance for different traits.

Sl. No.	Traits	Best genotypes
1.	Days to first flowering	Parbhani Kranti (57.44 days), Arka Anamika (57.70 days) and SK-BS-11 (58.60 days)
2.	Days to first fruit harvest	Parbhani Kranti (62.13 days) Hissar Unnat (63.37 days) and SK-BS-11 (63.47 days)
3.	Days to last fruit harvest	Elephant Tusk (159.91 days), Arka Anamika (158.89 days) and IC-18530 (157.06 days)
4.	Plant height (cm)	IC-18530 (194.89 cm), SK-BS-11 (192.50 cm) and Elephant Tusk (186.87 cm)
5.	Number of nodes plant^{-1}	Elephant Tusk (31.79), SK-BS-11 (30.77) and IC-18530 (29.94)
6.	Number of fruits plant^{-1}	SK-BS-11 (40.88), Elephant Tusk (38.27) and IC-18530 (35.28)
7.	Fruit length (cm)	Elephant Tusk (11.11 cm), SK-BS-11 (10.93 cm) and IC-18530 (9.54 cm)
8.	Fruit girth (cm)	IC-18530 (1.53 cm), Pusa Sawani and EC-306748 (both 1.40 cm)
9.	Average fruit weight (g)	Arka Anamika (10.16 g), SK-BS-11 (10.11 g) and IC-18530 (9.90 g)
10.	Number of ridges fruit^{-1}	EC-306748 (5.93) and IC-18530 (5.82)
11.	Fruit yield plant^{-1} (kg)	SK-BS-11 (0.41 kg), Elephant Tusk (0.36 kg) and IC-18530 (0.35 kg)
12.	Fruit yield plot^{-1} (kg)	SK-BS-11 (3.30 kg), Elephant Tusk (2.91 kg) and IC-18530 (2.79 kg)
13.	Number of seeds fruit^{-1}	EC-306748 (63.44), IC-18530 (61.04) and Pusa Sawani (52.13)
14.	100 seed weight (g)	Hissar Unnat (6.83 g), SK-BS-11 (6.25 g) and Pusa-A-4 (6.15 g)

nodes plant^{-1} (30.77), number of fruits plant^{-1} (40.88), fruit length (10.93 cm), average fruit weight (10.11 g), fruit yield plant^{-1} (0.41 kg), fruit yield plot^{-1} (3.30 kg), and 100 seed weight (6.25 g). Hence, the genotypes identified in this study, could be passed on to breeders for utilization in the okra improvement programs.

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