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Evaluation of okra (*Abelmoschus esculentus* L. Monech) germplasms for fruit yield and its components

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Abstract
Field experiment was conducted at AICRP on Vegetable Crops of OUAT, Bhubaneswar during *Kharif*, 2018-19 to study the performance of okra germplasm. Forty six germplasms of okra including four released varieties as check were grown by adopting Randomized Block Design replicated twice.

The results revealed significant variations among fifteen different traits. The plant height varied from 75.66 cm (BBSR-31) to 134.16 cm (Super green), nodes plant^{-1} from 18.66 no.s (BBSR-3, BBSR-23, BBSR-52 and BBSR-09-15) to 24.66 no.s (Super green, BO-2, BBSR-09-2 and BBSR-44), node at which 1st flowering occurred from 3.33(BBSR-09-15, Super Green) to 6.00(BBSR-23) and stem diameter from 3.83 (BO-1) to 6.64 (JOL2K-19). Number of primary branches plant^{-1} varied from 18.66 to 24.67 invariably, days to 1st and 50% flowering varied from 35.06 days (BBSR-50) to 49.00 days (Mukta) and 43.83 days (BBSR-31) to 59.00 days (Mukta) respectively. Fruit length varied from 10.42 cm (BBSR-31) to 18.84 cm (JOL2K-19) while that of fruit breadth 1.34 cm (BBSR-31) to 2.90 cm (BBSR-09-6). Maximum fruits plant^{-1} was recorded in BBSR-27(14.17). Similarly, average fruit weight varied significantly among the total genotypes from 10.07 gm. (BO-2) to 18.91 gm. (K-442). Incidence of YVMV revealed significant variations among germplasms which varied from 55.89% (BBSR-44 and Super Green) to 85.45% (Pusa Sawani). Total fruit yield plant^{-1} varied significantly ranging from 65.39 gm. (BBSR-31) to 233.75 gm. (Super green).

Thus, the availability of wide variability among the germplasms provided enough opportunities for their improvements in okra. Super green was identified as best germplasm having earliest node at which 1st flowering appeared, highest nodes plant^{-1} along with total yield plant^{-1}. Similarly, BBSR-44 may be taken as a parent for development of high yielding genotype with moderately susceptible to YVMV in future crop improvement programme.

Keywords: Evaluation**,** germplasms, okra, performance, YVMV

Introduction
Okra (*Abelmoschus esculentus* L. Moench.) known as Lady's finger is an important dicotyledonous warm season vegetable crop belonging to the family Malvaceae. It is originated in tropical Africa (Purseglove, 1987) and is grown as a popular vegetable throughout the tropical and sub-tropical regions of the world. It is an annual, erect growing, high yielding crop with numerous cultivars varying in plant height, degree of branching and pigmentation of the various parts, period of maturity, and pod shape and size. Okra is a magically versatile vegetable having easy digestible fibre content, low in calories along with fat free nature (Kumar and Sreeparvathy, 2010; Reddy *et al*., 2013) [9, 14]. In India, okra is one of the most important vegetable crop grown for its tender green fruits during summer and rainy seasons. It is a nutritious vegetable containing 86.1% water, 2.2% protein, 0.2% fat, 9.7% carbohydrate, 1.0% fiber and 0.8% ash (Saifullah and Rabbani, 2009) [15]. India ranks first in the production of okra contributing 73.25% of world's production (Indian Horticulture Database, 2011). However, the productivity (11.9 MT/ha) is much less than the potential productivity (Horticulture statistics, 2018-19). In spite of multiple economic importance, okra is facing lower production potential because of the non-availability of high yielding, improved and locally adapted cultivars, narrow genetic base of existing varieties and higher reduction in yield due to heavy incidence of biotic stresses such as fruit and shoot borer at preflowering and flowering stage and YVMV from vegetative, flowering till up to fruit setting stage. Therefore, selection of the potential existing local cultivars on the basis of mean performance is essential to enrich genetic diversity of the base cultivars which further facilitates improvement in breeding programme.

The field experiment was conducted at All India Co-ordinated Research Project on Vegetable Crops, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India during *kharif*, 2018-19 to study the performance of okra germplasms for yield and other yield attributing characters along with tolerance to YVMV. The experiment was laid out in Randomized Block Design and replicated twice, with 46 genotypes including four released varieties as check. All the recommended package of practices were adopted uniformly to all the genotypes in order to raise a good crop. Observations on vegetative, flowering, fruit yield and yield attributes were collected from randomly selected plants and were subjected to statistical analysis.

Vegetative growth parameters

The mean performance of vegetative growth parameters for 46 germplasm of okra are presented in table1. Significantly, maximum plant height at final harvest stage was recorded by Super green (134.16 cm), whereas BBSR-31 (75.66 cm) recoded the lowest one among all landraces. The data stem diameter indicated wide variations among tested genotypes ranging from 6.64 (JOL2K-19) to 3.83 (BO-1) with a mean value of 5.40. Genotypes BO-13 (6.62), K-442 (6.56) and Pusa Sawani (6.42) were showed *statistical parity* with JOL2K-19. Plant height and stem diameter are important index of vigorous growth of the plants which leads to get higher productivity and also necessary for selection programmes aimed at improving desirable traits in okra. This collaborates with the findings of Shivaramegowda *et al.* (2016); Chadha *et al*. (2014); Pandey *et al*. (2017) and Ansari *et al.* (2020) [16, 4, 12, 2].

Table 1: Mean Performance of 46 okra germplasms (48 germplasms) for 15 characters

Genotype	PH	SD	NP	FN	DFF	D50F	FL	FG	AFW	F/P	PDI 30	PDI 45	PDI 60	PDI 75	Y/P
BBSR-3	99.93	5.20	18.66	4.33	41.80	50.03	11.14	2.69	13.03	8.45	0.71	26.66	48.20	66.10	87.47
BBSR-4	119.03	4.20	21.66	5.00	41.93	51.76	15.22	1.78	15.26	11.30	0.71	22.35	42.87	59.49	109.41
BBSR-7	105.36	5.51	19.66	5.00	41.20	52.16	14.08	1.54	12.69	9.88	0.71	20.60	36.28	56.25	71.81
BBSR-10	112.46	4.16	21.66	5.66	41.60	50.80	15.72	1.65	14.13	11.59	0.71	34.10	51.22	63.72	94.32
BBSR-11	90.86	5.61	19.66	5.00	41.80	51.76	14.94	1.75	13.41	9.69	0.71	23.81	50.47	60.76	96.26
BBSR-13	120.31	4.24	23.33	5.00	35.86	45.06	13.30	1.45	13.82	11.30	0.71	28.01	46.07	64.25	136.11
BBSR-18	109.53	6.24	21.66	3.00	40.33	50.40	13.72	1.99	16.67	11.78	0.71	24.09	38.42	58.50	136.39
BBSR-22	81.63	5.33	19.66	3.66	43.73	54.23	15.60	1.82	12.82	9.69	0.71	26.47	43.80	65.47	77.10
BBSR-23	85.70	5.15	18.66	6.00	41.40	52.00	11.41	1.56	14.59	9.02	0.71	39.65	58.41	72.47	89.34
BBSR-24	120.73	4.82	20.66	3.67	41.76	52.20	17.54	1.90	17.98	10.83	0.71	26.47	43.80	64.87	122.32
BBSR-26	116.56	4.90	19.33	4.00	42.66	53.50	16.49	1.86	16.18	9.21	0.71	26.66	47.14	64.56	88.99
BBSR-27	116.83	4.25	22.66	4.33	42.30	53.00	15.90	1.89	18.19	14.07	0.71	26.78	47.12	64.75	111.20
BBSR-29	116.13	6.55	19.33	5.34	42.13	52.13	12.44	2.03	17.07	11.97	0.71	32.90	52.60	66.10	143.87
BBSR-30	123.30	5.05	20.67	4.00	41.60	52.40	12.14	1.71	13.18	11.95	0.71	25.12	41.41	63.33	118.85
BBSR-31	75.66	6.16	19.67	5.33	35.93	43.83	10.42	1.34	10.10	8.17	0.71	37.38	53.60	64.87	65.397
BBSR-36	121.76	6.07	22.67	5.00	42.00	52.16	12.62	1.83	18.82	12.06	0.71	25.24	42.39	63.53	144.06
BBSR-37	110.93	6.16	20.67	5.00	44.26	55.03	16.11	1.81	14.38	11.54	0.71	21.01	42.87	59.41	101.39
BBSR-44	130.90	4.99	23.66	5.00	39.20	49.30	17.54	1.94	18.54	14.00	0.71	17.52	39.65	55.89	162.88
BBSR-47	98.13	5.49	19.34	4.67	38.80	48.80	17.09	2.03	17.16	10.45	0.71	22.55	42.60	60.76	117.36
BBSR-49	116.33	5.90	22.67	4.00	41.20	51.86	12.75	2.02	11.45	10.83	0.71	22.35	43.93	61.15	77.40
BBSR-50	115.26	5.64	21.66	5.00	35.06	44.96	17.06	1.91	16.37	11.78	0.71	33.90	52.50	70.93	132.30
BBSR-52	94.36	6.01	18.66	4.00	42.13	52.10	14.24	1.84	16.64	10.83	0.71	25.46	48.20	66.70	109.89
BBSR-53	128.76	6.01	24.66	4.34	42.00	52.50	16.29	1.78	16.81	13.01	0.71	22.58	42.74	64.32	152.69
BBSR-56	112.96	4.57	20.66	5.55	37.93	47.96	18.14	1.81	17.65	11.49	0.71	39.57	60.64	67.64	142.85
BBSR-57	128.70	4.36	22.66	4.66	42.06	52.36	17.20	2.00	17.28	11.49	0.71	36.36	55.89	70.93	139.40
BBSR-59	122.63	6.09	19.66	4.66	41.46	53.20	14.23	2.18	15.34	11.30	0.71	36.39	58.26	64.87	116.33
BBSR-09-2	130.56	4.05	24.66	4.33	36.86	44.90	13.30	1.57	14.83	12.06	0.71	40.73	60.64	68.05	119.58
BBSR-09-3	94.30	5.07	19.66	4.33	35.80	45.10	15.96	1.76	18.08	10.83	0.71	21.01	42.87	59.41	126.46
BBSR-09-6	95.13	5.49	20.33	4.66	41.26	52.10	17.44	2.90	18.11	10.45	0.71	19.60	40.73	57.11	120.34
BBSR-09-15	93.16	5.07	18.66	3.33	44.06	54.40	18.02	1.86	18.40	5.51	0.71	34.11	53.63	65.26	76.53
BO-1	114.70	3.83	22.33	4.33	45.20	54.83	16.47	1.89	15.76	13.58	0.71	22.55	43.93	60.76	141.64
BO-2	128.60	5.50	24.66	4.33	36.66	46.86	14.83	1.66	10.07	12.92	0.71	29.48	50.34	69.39	90.53
B0-13	106.23	6.62	19.33	5.00	42.13	54.23	14.63	1.72	14.02	10.64	0.71	39.65	59.41	66.41	95.28
VS-7109	87.30	5.50	20.33	4.66	36.26	45.60	18.32	1.94	13.86	9.40	0.71	29.35	49.26	67.64	100.13
VRO-51	110.30	5.46	20.33	4.33	37.93	47.93	17.09	1.78	17.55	11.30	0.71	38.55	57.26	68.36	138.42
JOL2K-19	126.56	6.64	22.66	4.33	38.73	48.86	18.84	1.94	15.46	12.63	0.71	39.65	59.41	66.41	135.37
K-442	100.16	6.56	20.66	4.00	42.26	52.26	14.86	1.77	18.91	9.78	0.71	39.65	59.41	68.36	125.58
Keonjhar local	132.03	5.61	23.66	5.33	42.00	52.33	15.96	2.03	15.91	13.58	0.71	29.38	51.45	62.18	148.86
Prerna	114.63	4.70	20.66	5.00	41.06	50.60	12.24	1.61	11.62	12.63	0.71	36.39	58.26	67.64	113.19
Mukta	119.83	5.99	19.33	4.00	49.00	59.00	17.32	2.02	17.91	7.83	2.74	21.17	43.93	60.84	83.07
Super green	134.16	5.76	24.33	3.33	45.06	55.13	15.08	1.68	18.02	14.16	0.71	15.57	39.65	55.89	233.75
Arka Abhay	109.33	5.81	19.33	3.66	36.23	45.93	13.93	1.56	12.70	11.65	0.71	21.17	42.60	60.76	122.75
Arka Anamika	123.90	4.99	23.33	4.33	42.13	52.33	15.96	1.68	15.27	11.11	0.71	15.62	40.46	58.50	142.66
Kashi Kranti	102.36	5.89	20.33	4.33	42.46	52.46	14.50	1.82	14.38	9.59	0.71	15.39	40.73	57.11	101.78
Kashi Pragati	110.50	4.70	19.33	4.66	36.86	46.93	16.15	1.61	13.49	10.16	0.71	29.38	49.45	63.53	96.92
Pusa Sawani	79.90	6.42	20.33	5.33	42.46	52.26	13.40	2.13	12.44	8.07	0.71	39.65	65.47	85.45	56.54

Mean	110.61	5.40	21.05	4.54	40.79	50.86	15.17	1.85	15.35	10.99	0.75	28.30	48.69	64.15	115.54
S.E(m)	2.23	0.11	0.26	0.09	0.43	0.49	0.30	0.04	0.35	0.26	0.04	1.12	1.09	0.77	4.61
S.E(d)	15.16	0.75	1.81	0.61	2.95	3.33	2.12	0.27	2.40	1.74	0.29	7.64	7.39	5.28	31.26
CD	8.31	0.30	0.94	0.98	0.95	1.13	1.13	0.20	0.65	0.90	0.42	5.44	4.96	10.23	13.09
CV	4.69	3.45	2.78	13.53	1.45	1.39	4.64	6.62	2.63	5.14	34.42	12.01	6.36	9.97	7.08

PH- Plant height at final harvest (cm), SD- Stem diameter (cm), NP- Nodes plant^{-1}, FN- Nodes at first flowering, DFF- Days to 1st flowering, D50F- Days to 50% flowering, FL- Fruit length (cm), FG- Fruit girth (cm), AFW- Average fruit weight (g), F/P- Fruits plant^{-1}, PDI30 -YVMV% at 30 DAS, PDI45 –YVMV % at 45 DAS, PDI60 –YVMV % at 60 DAS, PDI75 –YVMV % at 75 DAS, Y/P- fruit yield plant^{-1}(g)

Flowering parameters

Nodes plant^{-1} varied from 18.66 to 24.67. Maximum number of nodes plant^{-1} were reported in genotype BBSR-44 (24.67) followed by BO-2(24.66), BBSR-09-2 (24.66) and Super Green (24.33). Similarly, node at which first flower appeared, showed significant variation among all genotypes of okra. The genotypes like BBSR-24(3.67), Super Green (3.33) and BBSR-09-15(3.33) showed significantly earliest node at which first flower appeared. These results were in close accordance with Mohammad *et al*., 2022 and Reddy *et al*., 2022 [20] in okra. Days to first flowering ranged from 35.06 days to 49 days. The datas were recorded from table 1 also revealed that the earliest days to 1st flowering was recorded by genotype BBSR-50 (35.06 days) followed by BBSR-09-3 (35.80 days), BBSR-13 (35.86 days) and BBSR-31(35.93days). Similarly, minimum number of days to 50% flowering was recorded by BBSR-31 (43.83 days). The genotype Mukta (49.00 days and 59.00 days) was the late one for days to 1st flowering and 50% flowering. The variation might be due to its genetic makeup of short vegetative phase which enhance its early flowering. Similar reports are also observed by Aminu *et al*., 2017, Mahapatra *et al*., 2007, Binalfew *et al*., 2016 and Pandey *et al*., 2017 [1, 10, 3, 12] in okra.

Fruit yield attributing parameters

Fruit yield attributing parameters *viz*., fruit length, fruit breadth, fruit weight and number of fruits plant^{-1} showed significant variation among all the genotypes of okra (Table 1). Among the genotypes, significantly longest fruit was recorded in JOL2K-19 (18.84 cm) subsequently followed by VS-7109 (18.32 cm) whereas, genotype BBSR-31 showed significantly lowest fruit length of 10.42 cm. BBSR-09-6 (2.90 cm) was found to have the highest value for fruit girth among the genotypes and the lowest value was recoded with BBSR-31 (1.34 cm). Heaviest fruit of 18.91 g. was recorded in K-442 followed by BBSR-36 (18.24 g); whereas BO-2 recorded lightest weight fruit of 10.02 g. Significant variation was observed among these genotypes for number of fruits plant^{-1}. Genotype Super Green (14.16) showed highest number of fruits plant^{-1} whereas genotype BBSR-09-15 (5.51) recorded lowest number of fruits plant^{-1}.Fruit length, fruit breadth, fruit weight and fruits plant^{-1} are important yield enhancing parameters. Variations observed among the genotypes for these traits are due to environment influence and inherent genetic potential of each genotypes. These results are in consonance with that of (Pandey *et al.*, 2017; Singh *et al*., 2017, Koundinya *et al.*, 2013 Jindal and Deepak., 2010) [12, 17, 8, 7].

Regarding the percentage of YVMV incidence, the severity of effect recorded highest in genotypes like Pusa Sawani (85.45%), BBSR-23 (72.47%), BBSR-57 and BBSR-50 (70.93%) while genotypes like 'Super Green and BBSR-44' (55.89%) were lowest at 45, 60 and 75 DAS respectively. These results were also similar to the findings of Chattopadhya *et al.* (2011) and Das *et al.* (2013) and Solankey *et al*. (2014) [5, 6, 19].

Fruit yield parameters

Among the germplasms evaluated, the highest fruit yield plant^{-1} was recorded in Super green (233.75 g) followed by BBSR-44 (162.86 g) and BBSR-53 (152.69 g). The lowest fruit yield plant^{-1} was recorded by Pusa Sawani with the value of 56.54 g (Table 1). Similar results were observed by Pandey *et al*., 2017; Singh *et al.*, 2017 and Jindal and Deepak. 2010 [12, 17, 7]. In the present investigation based on *per se* performance, the genotype Selection from Super Green was identified as best germplasm due to significantly earliest node at which 1st flowering appeared, highest number of fruits plant^{-1} and fruit yield plant^{-1} along with moderately susceptible to YVMV. Similarly, BBSR-44 may be taken as a parent for development of heaviest fruit, high yielding genotype along with moderately susceptible to YVMV in future crop improvement programme.

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