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Comprehensive assessment of ridge gourd [*Luffa acutangula* (L.) Robx.] Genotypes: Insights into growth, seed yield and quality traits

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Abstract
Field experiment was conducted to evaluate twenty ridge gourd genotypes for growth and seed yield at Research and Development Station of Orbi Seeds International Private limited Sadahalli, during *rabi*-summer, 2022-23 and laboratory experiments on seed quality were conducted at Seed Technology Research Centre, AICRP on Seed (Crops) and Department of Seed Science and Technology, GKVK, University of Agricultural Sciences, Bangalore. The results indicated that, all the genotypes differed significantly for growth, seed yield and quality parameters. The genotype OSRG-007 recorded higher vine length at maturity (4.71 m), lower sex ratio (12.56), more number of fruits per vine (8.77), average fruit weight (889.28 g), fruit yield (39.84 t ha-1), number of seeds per fruit (152), seed yield per vine (205.73 g) and seed yield (10.35 q ha-1). Among the twenty genotypes, the genotype OSRG-016 recorded significantly higher seed quality parameters *viz*., seed germination, mean seedling length, mean seedling dry weight, seedling vigour index-I and II (94%, 38.47 cm, 100.95 mg, 3224, 9489 respectively) and lower electrical conductivity (100.4 µS/cm/g).

Keywords: Genotypes, sex ratio, fruit yield, seed yield, seed quality

Introduction
The ridge gourd (*Luffa acutangula* (L.) Roxb.) is also known as herekaie, Kalitori, Chinese okra, silky gourd, ribbed gourd, angled gourd and angled loofah. It is a member of the Cucurbitaceae family and has chromosomal number 2n = 26. The term "loofah" refers to a material used in door mats, cushions, mattresses, bathing sponges, scrubbing pads and kitchen utensil cleaning. It contains the pharmacologically significant gelatinous substance “luffein”.
India has the reputation of producing 340 Mt of vegetables over 28.3 Mha, placing it second among the world's vegetable producers. Ridge gourd cultivation in India covers an area of 9920 ha generating a substantial production of about 3.17 lakh t with a productivity of 31.95 t ha-1 (Anon., 2022) [2-3] whereas, Karnataka occupies 0.51 Mha with a production of 8.1 Mt of vegetables. Ridge gourd is cultivated on 4200 ha with a production of 38,882 t and productivity of 9.26 t ha-1 in Karnataka (Anon., 2022) [2-3]. However, the number of vegetables available per person in India is as low as 160 gm, compared to the 300 g per day recommended by the FAO.
According to the forecast, an additional 27.2 million tonnes of vegetables other than potatoes and other tubers will be required to ensure the nutritional security of the expanding population.
The ridge gourd is a tough climber with a long tap root system, and its simple, oval, green leaves have 5-7 lobes. Despite the fact that cultivated species are monoecious, various sex forms, including andromonoecious, gynomonoecious, gynoecious, and hermaphrodite plants, are also reported in nature (Thakur and Choudhary., 1965) [19]. Synandry, or five-stamented staminate flowers, are carried in 10 to 20 flowered racemes, whilst short- or long-pedunculated, fragrant pistillate blooms are found alone. On the axil of the leaf, pistillate and staminate flowers are produced. Anthesis begins between 4 and 6 P.M., lasts all through the night, it is finished by early morning, when flowers are prepared for pollination and selfing. Temperature and humidity are factors that affect anthesis and dehiscence. The pistil has three placentae and several ovules, and the anthers are free. There are three bilobate stigmas. Botanical description of ridge gourd fruit is pod. Fruit has 10 noticeable ridges, club-shaped slightly tilted with numerous seeds.

On reaching maturity, it becomes ridged, hard, and inedible. The seeds are wrinkled, flattened, and black. 1000 seeds typically weigh between 150 and 170 g (Doijode, 2002) [4].

Materials and Methods

The field experiment was conducted at Research and Development Station of Orbi Seeds International Private limited Sadahalli, during *rabi*/summer, 2022. The laboratory experiments were conducted at the Seed Technology Research Centre, AICRP on Seed (Crops) and Department of Seed Science and Technology, Gandhi Krishi Vignan Kendra, University of Agricultural Sciences, Bangalore. The study involved 20 diverse genotypes collected from Orbi Seeds International Private limited, Yelahanka. The experiment was laid out in the randomized block design with three replications. The experimental plot size was 40 m2. In each replication, every genotype was represented by two rows, with each row accommodating 10 plants. The spacing between rows was 3.0 meters and the spacing between plants within a row was 1.0 meters.

Following extensive site preparation, the experiment was set up as planned. Black plastic mulch was laid up in 4.0 metre broad beds. The seedlings were cultivated in protrays after the seeds were treated with captan at a dosage of 3 g per Kilogramme of seed. At the 2-4 leaf stage and 3.0 m apart on both sides of the beds, seedlings were transplanted during the fourth week of November 2022. The land got a mild irrigation after the transplanting. All other farming techniques were carried out in accordance with the "Improved Packages of Practices for Horticultural Crops" issued by the University of Horticultural Sciences, Bagalkot (Anon., 2019) [1]. Five plants at random from each genotype and replication were selected to be evaluated for their quantitative traits. The Panse and Sukhatme-recommended methodology were used to conduct statistical analysis on the acquired data (1967).

The twenty genotypes of ridge gourd were selected for the study and the fresh seeds were collected from the selfed fruits of each genotype from Orbi Seeds International Private limited Sadahalli. Various seed yield parameters like vine length at maturity (m), sex ratio (M: F), days to maturity, fruit length (cm), fruit girth (cm), average fruit weight (g), fruit yield per vine (kg), fruit yield per hectare (t/ha), number of seeds per fruit, seed yield per vine (g), seed yield per hectare (q/ha) and seed quality parameters like seed germination (%), root length (cm), shoot length (cm), mean seedling length (cm), mean seedling dry weight (mg), EC (µS/cm/g), seedling vigour index–I and seedling vigour index II were recorded.

Results and Discussion

The genotypes differed significantly with respect to vine length at maturity (Table 1). The genotype OSRG-007 recorded the maximum vine length (4.71 m) followed by OSRG-014 (4.49 m) and the genotype OSRG-011 recorded the minimum vine length of 3.46 m. The vine length was highly heritable in nature and variation in plant height among the genotypes might be due to genetic make-up of genotype. Similar variation for vine length was also reported by Khanikar *et al*. (1995) [8] in ridge gourd. Raja *et al*. (2007) [13], Yadav and Kumar (2011) [20], Sharma and Sengupta (2013) [16], Harika *et al*. (2012) [6], Singh and Singh (2014) [17] and Jamal Uddin *et al*. (2014) [7] in bottle gourd.

The genotypes vary significantly in terms of sex ratio (Table 1). The genotype OSRG- 011 had maximum number of male flowers (22.85) per female flower. Whereas least sex ratio was observed in OSRG-007 (12.56). Sex expression is influenced by environmental conditions like light, moisture, temperature, nutritional requirements etc. (Frankel and Galun, 1977) [7]. The variation in sex ratio could be attributed to the inherent qualitative characteristics of each genotype, capacity of genotype to withstand the adverse climatic condition and it was also discovered that the proportion of staminate to pistillate flowers could be materially modified by environmental factors. The results are similar to those obtained by Shah and Kale (2002) [15] in ridge gourd.

Significant difference for days to maturity was found among the different genotypes (Table 1). The genotype OSRG-007 recorded minimum days for maturity of 84.33 DAT. The maximum days to maturity was observed in genotype OSRG-011 (90.00 DAT). Usually, variations in the quantitative traits are due to environmental factors. However, days to maturity is mainly influenced by the performance of genotypes (genetic makeup) even grown under identical environmental conditions. Similar results were also observed by Rathore *et al*. (2017) [14] in ridge gourd. Fruit length and girth of all the genotypes differed significantly (Table 1). The genotype OSRG-007 possessed longest fruits (56.23 cm) and maximum fruit girth (16.30 cm). However, significantly minimum fruit length (27.26 cm) and minimum fruit girth (7.53 cm) was recorded in OSRG-011. The observed variation in fruit length and fruit girth among different genotypes can be attributed to the genetic variability and inherent characteristics governing various fruit shapes.

Table 1: Yield parameters in ridge gourd genotypes

Genotypes	Vine length at maturity (m)	Sex ratio (M: F)	Days to maturity	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	Fruit yield per vine (kg)	Fruit yield per hectare (t/ha)	No. of seeds per fruit	Seed yield per vine (g)	Seed yield per hectare (q/ha)
OSRG-001	3.67	22.34	89.07	31.98	10.90	537.91	2.78	13.90	93.33	86.37	4.31
OSRG-002	4.06	17.31	88.33	35.20	13.27	604.91	3.56	17.80	115.67	108.73	5.39
OSRG-003	3.78	19.86	89.00	32.41	11.27	550.8	2.95	14.75	95.33	91.42	4.60
OSRG-004	4.47	14.25	86.67	45.01	15.73	827.75	5.15	25.76	142.00	160.48	7.99
OSRG-005	4.10	16.97	88.00	35.29	13.50	654.37	3.70	18.51	120.33	115.56	5.83
OSRG-006	4.27	14.72	86.33	40.45	14.90	756.66	4.40	22.01	133.33	132.6	6.64
OSRG-007	4.71	12.56	84.33	56.23	16.30	889.28	7.89	39.84	152.00	205.73	10.35
OSRG-008	3.84	19.79	89.00	32.52	11.90	553.37	2.98	14.89	103.00	93.27	4.70
OSRG-009	4.23	16.40	87.33	37.97	14.47	672.34	3.91	19.55	125.67	121.45	6.13
OSRG-010	3.61	22.61	89.62	31.04	9.57	519.47	2.58	12.90	91.00	83.59	4.20
OSRG-011	3.46	22.85	90.00	27.26	7.53	487.98	2.49	12.45	90.00	81.26	4.10
OSRG-012	4.20	16.68	87.67	35.68	13.93	660.13	3.79	18.96	123.67	120.19	6.01
OSRG-013	4.41	14.29	86.67	40.50	15.20	760.27	4.46	22.29	135.67	156.2	7.79

OSRG-014	4.49	13.64	85.67	45.96	16.07	863.58	5.49	27.44	144.67	178.18	8.90
OSRG-015	4.25	16.19	87.00	38.57	14.47	692.76	4.08	20.43	132.33	128.02	6.43
OSRG-016	3.93	18.37	88.67	33.85	12.70	568.82	3.19	15.96	107.67	102.11	5.11
OSRG-017	4.04	17.35	88.33	35.00	13.20	581.04	3.48	17.40	111.33	105.85	5.31
OSRG-018	4.06	17.28	88.00	35.22	13.43	626.69	3.66	18.30	116.33	115.22	5.81
OSRG-019	3.84	18.67	88.67	32.88	12.03	560.54	3.13	15.65	104.00	100.49	5.00
OSRG-020	4.00	17.48	88.67	34.68	12.90	578.54	3.37	16.84	110.67	103.38	5.19
Mean	4.07	17.48	87.82	36.89	13.16	647.36	3.85	19.28	117.40	119.51	5.99
S.Em ±	0.16	0.27	1.00	3.04	0.96	40.15	0.31	1.34	4.43	8.67	0.46
CD at 5%	0.45	0.78	2.86	8.69	2.74	114.96	0.90	3.85	12.69	24.81	1.31
CV (%)	6.71	2.68	1.97	14.26	12.57	10.74	14.06	12.08	6.54	12.56	13.28

Average fruit weight, fruit yield per vine and fruit yield per hectare differed significantly among genotypes (Table 1). The genotype OSRG-007 recorded highest fruit weight (889.28 g), fruit yield (7.89 kg) per vine and fruit yield per hectare (39.84 t ha-1). While, lowest fruit weight (487.98 g), fruit yield per vine (2.49 kg) and fruit yield per hectare (12.45 t ha-1) were recorded in OSRG-011. Differences in yield and yield-related characteristics among the various varieties can be attributed to variations in their morphological and physiological traits, which consequently affect the translocation of carbohydrates from source to sink. Noteworthy variations in morpho-physiological attributes were detected among the varieties, likely stemming from their distinct genetic compositions.

Number of seeds per fruit, seed yield per vine (g) and seed yield per hectare (q/ha) varied significantly among genotypes (Table 1). Among genotypes, OSRG-007 recorded significantly higher number of seeds per fruit (152.00), seed yield per vine (205.73 g) and seed yield per hectare (10.35 q ha-1). Significantly lower number of seeds per fruit (90.00), seed yield per vine (81.26 g) and seed yield per hectare (4.10 q ha-1) were recorded in OSRG-011.Similar results were obtained by Hanumegowda *et al.* (2012) [5], Narasannavar *et al.* (2014) [10] in ridge gourd. The observed variation in this quantitative trait among the genotypes can be primarily attributed to a combination of factors, including differences in their genetic composition, the influence of environmental conditions, availability of nutrients, and the genotype's capacity to tolerate fluctuating temperatures.

The data on seed quality parameters *viz.*, seed germination (%), root length (cm), shoot length (cm), mean seedling length (cm), mean seedling dry weight (mg), electrical conductivity (µS/cm/g), seedling vigour index-I, seedling vigour index-II of different genotypes were presented in Table 2.

The genotype OSRG-016 recorded highest (94%) seed germination, root length (22.28 cm), shoot length (18.43 cm), mean seedling length (38.47 cm), mean seedling dry weight (100.95 mg), SVI-I (3224) and SVI-II (9489). While lowest seed germination (63%), root length (13.53 cm), shoot length (11.16 cm), mean seedling length (25.89 cm), mean seedling dry weight (66.35 mg), SVI-I (1649) and SVI-II (4180) were observed in genotype OSRG-005. Genotypes exhibiting enhanced seed germination displayed notably elevated average seedling length, along with increased root and shoot length. The similar results were also reported by Kumar *et al.* (2013) [9] and Pal *et al.* (2017) [11] in cucumber and Sithole *et al.* (2016) [18] in bottle gourd.

Among the genotypes significantly lowest (100.40 µS/cm/g) electrical conductivity was observed in genotype OSRG-016 and the highest was observed in OSRG-005 (271.5 µS/cm/g).

Table 2: Initial seed quality parameters of ridge gourd genotype

Genotypes	Seed germination (%)	Root length (cm)	Shoot length (cm)	Mean seedling length (cm)	Mean seedling dry weight (mg)	EC (µS/cm/g)	SVI-I	SVI-II
OSRG-001	83	20.85	16.31	35.11	90.64	182.7	2736	7523
OSRG-002	65	16.87	13.42	32.88	85.82	217.9	2240	5578
OSRG-003	88	21.55	17.51	36.82	91.92	165.8	2913	8089
OSRG-004	68	18.50	13.64	33.23	86.98	198.2	2423	5915
OSRG-005	63	13.53	11.16	25.89	66.35	271.5	1649	4180
OSRG-006	64	16.03	12.45	29.80	80.95	225.1	2070	5181
OSRG-007	91	21.56	17.82	37.80	91.99	143.7	3014	8371
OSRG-008	80	20.04	15.03	33.77	88.11	191.7	2640	7049
OSRG-009	63	14.73	11.77	26.29	79.23	241.1	1901	4991
OSRG-010	64	16.70	12.76	30.34	81.45	223.3	2158	5213
OSRG-011	83	21.03	16.42	36.79	91.2	174.8	2832	7570
OSRG-012	71	18.57	13.89	33.53	87.16	196.2	2464	6188
OSRG-013	63	15.41	11.85	29.13	79.7	229.5	1916	5021
OSRG-014	93	21.81	18.41	38.35	98.78	127.5	3044	9187
OSRG-015	64	16.70	12.86	30.34	82.08	223.2	2200	5253
OSRG-016	94	22.28	18.43	38.47	100.95	100.4	3224	9489
OSRG-017	82	20.48	15.52	34.97	90.62	186.2	2710	7431
OSRG-018	66	17.35	13.52	33.02	86.26	216.2	2268	5693
OSRG-019	80	20.16	15.26	34.26	89.39	187.5	2660	7151
OSRG-020	63	15.91	12.26	29.55	80.95	227.6	1973	5100
Mean	74.4	18.5	14.51	33.02	86.53	196.51	2452	6509
S.Em ±	1.53	0.3	0.17	0.37	1.31	3.52	58.02	89.60
CD at 5%	4.36	0.85	0.48	1.07	3.75	10.07	165.84	256.10
CV (%)	3.55	2.79	1.98	1.96	2.62	3.1	4.09	2.38

Increased EC values often correlate with weakened seed coat integrity, leading to the leakage of soluble solutes. This, in turn, can have a negative impact on the overall quality of the seeds. Varieties with lower EC values tend to demonstrate superior seed quality. This outcome aligns with the discoveries of Sithole *et al*. (2016) [18] in bottle gourd.

Conclusion

Among the twenty genotypes examined, genotype OSRG-007 showed better growth and higher seed yield parameters of ridge gourd and seed quality attributes were proven best in OSRG-016 compared to all other genotypes.

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