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Evaluation of Ginger (*Zingiber officinale* Rosc.) Germplasms for Growth and Yield Attributes in the New Alluvial Zone of West Bengal

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ABSTRACT

An experiment was conducted to assess the growth and yield attributes of ginger germplasm at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during 2019–20 and 2020–21. The experiment was designed in Randomized Block Design with 3 replications. A total of 18 treatments, comprising 15 germplasms and 3 varieties were evaluated. The results of the study revealed that Gorubathan has recorded maximum plant height, number of leaves per tiller, pseudostem girth, and dry yield. Surabhi recorded maximum leaf length, number of tillers per clump, leaf area, leaf area index, number of fingers per clump, number of primary fingers per clump, number of secondary fingers per clump, clump length, rhizome yield per clump, rhizome yield per plot and projected fresh rhizome yield, which was statistically at par with Hui Local for rhizome yield per clump, yield per plot and projected rhizome yield, whereas maximum leaf breadth and finger diameter were recorded in genotype Hui Local. The maximum clump breadth was recorded in Thingpuidum Local and the highest finger length was found in Banada Local. In conclusion, the study suggests that var Surabhi, Gorubathan, Nadia and cv Hui Local, Thinglaidum, Thingpuri and Banada Local are found to be promising in terms of growth and yield attributes in new alluvial zone of West Bengal.

Keywords Germplasm evaluation, Ginger, Growth, Yield, New alluvial zone.

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INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) is a well-known herbaceous perennial tropical and subtropical commercial rhizomatous spice crop belonging to the family *Zingiberaceae* (Jabborova *et al.* 2022). It is commercially cultivated and renowned for its distinct aroma, pungency, flavor, and medicinal properties (Spence 2023). Ginger is primarily cultivated in Southeast Asia, in tropical, subtropical and humid climates (Kumar *et al.* 2013). Since earlier days

ginger has been used to treat various ailments, like cold, nausea, arthritis, migraines and hypertension, and it possesses anti-inflammatory, anti-nausea, anti-cancer and antioxidant properties (Shadap *et al.* 2018). Besides its remarkable medicinal uses, ginger is a common spice in cooking and is used in various forms, including fresh, dried, or powdered. Ginger oil extracted from the rhizomes is also used in cosmetic and food industries (Bag 2018). Ginger pungency is mainly attributed to its primary constituents, gingerols (23–25%) and shogaol (18–25%) (Sharifi-Rad *et al.* 2017).

India currently leads global ginger production, with an annual output of 25,03,325 t from approximately 2,10,016 ha. In West Bengal, it is grown on 12,700 ha, yielding 138,998 t. However, West Bengal ginger productivity is quite low at 10.94 t/ha, in contrast to states like Madhya Pradesh (16.05 t/ha) and Karnataka (11.68 t/ha) (Anonymous 2022). West Bengal has shown immense potential for its commercial cultivation of ginger crops. However, the information on suitable improved varieties and agro-techniques for this region is scanty and systematic efforts to evaluate and promote improved ginger cultivars have been lacking. Nevertheless, there is tremendous potential to enhance production and productivity by developing suitable high-yielding varieties adapted to specific agro-climatic conditions in West Bengal. Considering the aforementioned factors, the present study aims to identify promising ginger genotypes that exhibit superior growth and yield attributes in New Alluvial Zone of West Bengal.

MATERIALS AND METHODS

An experiment was conducted for two consecutive years 2019–20 and 2020–21 to evaluate the ginger germplasms at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India, located at an altitude of 9.75 m above MSL (mean sea level) with 23º 5° North latitude and 89º East longitudes falls under the subtropical climatic zone of West Bengal. The experiment was laid out in Randomized Block Design with three replications using 18 treatments comprising 15 ginger germplasms collected from diverse ginger growing areas indifferent North-eastern states of India. Additionally, 3 varieties namely Nadia, Surabhi and Gorubathan were collected from ICAR-AICRP on Spices, Kalyani Voluntary Center, Bidhan Chandra Krishi Viswavidyalaya, Nadia, and evaluated in the New Alluvial Zone of West Bengal. The selected healthy treated rhizomes weighing 25–30 g were planted in well-prepared raised beds of 3 × 1 m plot size with a spacing of 30 cm × 25 cm in the month of mid–April. Well-decomposed farmyard manure @ 20–25 tonnes per hectare along with a recommended dose of fertilizers were applied and cultural practices were followed as per the package of practices. Observation data on various growth and yield parameters were recorded from five randomly selected plants of each genotype (treatment) in each replication. Growth parameters were observed 150 days after planting, while rhizome yield and its attributes were recorded after harvest. The pooled data from two years of crops was subjected to statistical analysis using the procedures outlined by Gomez and Gomez (1983).

RESULTS AND DISCUSSION

The present investigation was reported based on two years of pooled data on their growth and yield attributes, which showed significant differences among germplasms (Tables 1-3). Analysis of two years of pooled data showed that Gorubathan recorded the maximum plant height (54.31 cm), followed by Khasi Local (53.02 cm), Banada Local (52.92 cm) and Thingpuri (51.84 cm), compared to the minimum found in Nagaland Local (40.40 cm). Similar results were also reported by Chakraborty *et al*. (2018), Basak *et al.* (2019), Jyotsna *et al.* (2012). The variations in plant height among the ginger genotypes might be due to the different agro-climatic conditions, which were also reported by Sangeetha and Subramanian (2015), where plant height varied from 43.5 cm to 60 cm under Coimbatore conditions. The maximum number of leaves per tiller was recorded in Gorubathan (21.11), followed by Surabhi (19.44), Hui Local (18.51) and Banada Local (16.05), while Nagaland Local recorded the lowest number of leaves per tiller (9.84). Such variation in the number of leaves among the studies might be due to the different agro-climatic conditions and genotypic characters. The var Gorubathan recorded maximum pseudostem girth (1.18 cm) which was on par with Hui Local (1.15 cm) and Surabhi (1.12

Table 1. Performance of ginger germplasms on growth parameters at 150 days after planting.

Sl. No.	Treatments	Plant height (cm)	Leaves per tiller (no.)	Pseudostem girth (cm)	Leaf length (cm)	Leaf breadth (cm)	Tillers per clump (no.)	Leaf area (cm^2)	Leaf area index
1	Thingpuri	51.84	15.61	1.03	16.27	2.06	11.58	22.14	5.72
2	Banada Local	52.92	16.05	1.02	18.31	1.90	10.95	22.97	5.81
3	Hui Local	50.35	18.51	1.15	19.36	2.18	11.92	27.85	6.36
4	Tura Local	49.94	14.06	0.94	16.11	2.09	9.28	25.03	6.13
5	Khasi Local	53.02	15.82	0.99	18.30	2.03	10.74	24.51	5.90
6	Meghalaya Local	46.10	15.45	0.97	19.22	2.05	9.70	26.06	6.09
7	Thingria	46.41	13.22	0.97	16.59	1.77	9.41	19.41	5.50
8	Thingpuidum Local	43.27	12.09	1.00	17.34	1.86	9.81	21.45	5.57
9	Thinglaidum	51.28	17.87	1.08	19.48	1.89	11.43	24.28	5.86
10	Dibang Takeng	44.61	14.45	1.00	16.76	1.81	9.57	20.18	4.79
11	Takeng Local	50.09	16.02	1.05	17.03	1.85	10.92	20.83	5.55
12	Jorhat Local	47.22	13.98	0.90	17.17	1.87	10.55	21.30	5.79
13	Moran Ada	42.23	11.45	0.81	15.85	1.68	8.06	17.58	4.32
14	Tripura Local	45.20	12.15	0.85	17.46	1.84	9.26	21.05	5.04
15	Nagaland Local	40.40	9.84	0.83	15.21	1.72	9.03	17.31	4.87
16	Nadia	48.85	14.77	1.02	18.86	1.96	11.47	24.45	6.19
17	Surabhi	51.45	19.44	1.12	21.30	2.10	13.20	29.52	6.49
18	Gorubathan (Local check)	54.31	21.11	1.18	20.09	2.14	12.01	28.58	6.22
	SEm ±	0.554	0.237	0.013	0.296	0.022	0.121	0.615	0.161
	CD (p=0.05)	1.565	0.708	0.032	0.855	0.062	0.342	1.835	0.480

cm), while lowest girth was recorded in Moran Ada (0.81 cm). Contrary to these findings, Chakraborty *et al.* (2018) reported that the pseudostem girth was 2.28 cm in Gorubathan. The variation in pseudostem girth size in different germplasm might be due to the different growth habits of stems and different growing

Table 2. Performance of ginger germplasms on yield attributing characters at harvest.

Sl. No.	Treatments	Fingers per clump (no.)	Primary fingers per clump (no.)	Secondary fingers per clump (no.)	Clump length (cm)	Clump breadth (cm)	Finger length (cm)	Finger diameter (cm)
1	Thingpuri	14.08	5.16	8.91	16.20	8.43	8.15	2.30
2	Banada Local	11.09	4.11	7.53	16.00	8.27	9.21	2.28
3	Hui Local	15.08	5.99	9.06	18.00	9.32	8.30	2.51
4	Tura Local	12.05	4.62	7.33	15.10	7.73	7.22	2.01
5	Khasi Local	13.41	4.95	8.32	15.47	6.88	8.56	2.22
6	Meghalaya Local	11.88	4.64	7.11	14.82	6.45	6.30	2.02
7	Thingria	12.00	4.59	7.37	13.44	6.67	8.39	2.03
8	Thingpuidum Local	11.62	4.44	7.15	15.37	9.86	6.48	2.15
9	Thinglaidum	14.30	5.35	7.82	17.57	8.50	7.82	2.25
10	Dibang Takeng	11.08	4.27	6.97	14.70	6.51	7.02	1.90
11	Takeng Local	13.58	5.26	8.17	15.76	7.94	7.05	2.34
12	Jorhat Local	11.03	4.01	7.46	14.66	8.08	7.31	2.09
13	Moran Ada	9.93	3.80	6.75	11.40	5.41	5.86	1.80
14	Tripura Local	12.84	4.77	7.89	14.50	7.08	6.60	1.95
15	Nagaland Local	10.84	4.08	6.30	11.92	6.09	6.15	1.87
16	Nadia	14.11	4.83	9.61	16.81	9.24	6.37	2.36
17	Surabhi	16.64	6.27	9.94	20.05	8.35	8.67	2.46
18	Gorubathan (Local check)	15.90	6.11	9.76	18.73	9.11	8.23	2.43
	SEm ±	0.470	0.138	0.217	0.542	0.302	0.222	0.025
	CD (p=0.05)	1.400	0.410	0.648	1.618	0.902	0.662	0.071

Table 3. Performance of ginger germplasms on yield parameters at harvest.

Sl. No.	Treatments	Fresh rhizome yield			Dry yield (t/ha)
		Yield per clump (g)	Yield per plot (kg)	Projected yield (t/ha)	
1	Thingpuri	220.16	5.27	16.10	3.35
2	Banada Local	203.49	4.73	15.66	3.28
3	Hui Local	237.64	5.71	18.99	4.43
4	Tura Local	167.95	4.06	13.69	2.66
5	Khasi Local	199.92	4.45	15.31	3.12
6	Meghalaya Local	196.64	4.66	14.60	2.89
7	Thingria	183.08	4.31	14.05	2.78
8	Thingpuidum Local	211.95	4.34	15.15	3.18
9	Thinglaidum	227.76	5.46	16.84	3.95
10	Dibang Takeng	187.42	3.66	11.64	2.47
11	Takeng Local	212.29	4.94	15.73	3.23
12	Jorhat Local	200.70	4.40	14.91	2.96
13	Moran Ada	108.71	2.50	9.77	2.24
14	Tripura Local	137.30	3.97	12.67	2.73
15	Nagaland Local	130.68	3.48	11.26	2.56
16	Nadia	215.02	5.06	15.92	3.48
17	Surabhi	240.83	5.74	19.12	4.65
18	Gorubathan (Local check)	235.38	5.61	18.38	4.78
	SEm ±	7.890	0.257	0.628	0.055
	CD (p=0.05)	23.541	0.765	1.875	0.159

geographical areas. The maximum leaf length recorded in Surabhi (21.30 cm) was closely followed by Gorubathan (20.09 cm), Thinglaidum (19.48 cm) and Hui Local (19.36 cm), while the lowest was recorded in Nagaland Local (15.21 cm). The maximum leaf breadth was observed in Hui Local (2.18 cm) closely followed by Gorubathan (2.14 cm) and Surabhi (2.10 cm) while lowest leaf breadth was recorded in Moran Ada (1.68 cm). Similar finding was reported by Basak *et al.* (2019), where the Gorubathan has recorded the leaf length (22.87 cm) and leaf breadth (2.31 cm) in the Terai region of West Bengal. The differences in leaf length and leaf breadth among the different ginger germplasms might be due to the different growth habits of the germplasms as they are collected from different geographical origins with different environmental conditions. The var Surabhi was recorded with maximum number of tillers per clump (13.20) followed by Gorubathan (12.01) and lowest was recorded in Moran Ada (8.06). The maximum leaf area was recorded in Surabhi (29.52 cm^2) followed by Gorubathan (28.58 cm^2) and Hui Local (27.85 cm^2). The maximum leaf area index was also recorded in Surabhi (6.49) which was on par with the genotypes Hui Local (6.36), Gorubathan (6.22) and Nadia (6.19) while the minimum was recorded in Moran Ada (4.32). These germplasms showed less variation concerning leaf area and leaf area index.

The recorded two years of pooled data on the yield-attributing characters showed significant differences among ginger germplasms (Table 2). The characters like fingers per clump (no.), primary fingers per clump (no.), secondary fingers per clump (no.), clump length (cm), clump breadth (cm), finger length (cm), and finger diameter (cm). The maximum total number of fingers per clump was recorded in Surabhi (16.64) followed by Gorubathan (15.90), Hui Local (15.08), Thinglaidum (14.30), Nadia (14.11) and Thingpuri (14.08) whereas, minimum number of fingers per clump was recorded in Moran Ada (9.93). The maximum number of primary fingers per clump was recorded in Surabhi (6.27), which was statistically at par with Gorubathan (6.11) and Hui Local (5.99) whereas, minimum number of primary fingers per clump was recorded in Moran Ada (3.80), the maximum number of secondary fingers per clump was recorded in Surabhi (9.94) was statistically at par with Gorubathan (9.76) and Nadia (9.61) while the minimum was observed in Nagaland Local (6.30). The highest clump length was recorded in Surabhi (20.05 cm) followed by Gorubathan (18.73 cm), Hui Local (18.00 cm) and Nadia (16.81 cm), whereas the lowest clump length was found in Moran Ada (11.40 cm). Maximum clump breadth was recorded in Thingpuidum Local (9.86 cm), which was statistically at par with Hui Local (9.32 cm), Nadia (9.24 cm) and Gorubathan (9.11 cm) while the lowest was found in Moran Ada (5.41 cm). The highest finger length was recorded in Banada Local (9.21 cm) followed by Surabhi (8.67 cm), Khasi Local (8.56 cm), Thingria (8.39 cm) and Hui Local (8.30 cm), while the minimum length was recorded in Moran Ada (5.86 cm). In case of finger diameter maximum was recorded in Hui Local (2.51 cm), which was statistically at par with Surabhi (2.46 cm), Gorubathan (2.43 cm), Nadia (2.36 cm) and Takeng Local (2.34 cm) while the minimum finger diameter was found in Moran Ada (1.80 cm).

The pooled data of fresh rhizome yield per clump

(g), rhizome yield per plot (kg), projected yield per hectare (t) and dry yield per hectare (t) differed significantly among eighteen ginger germplasms (Table 3). The data revealed that cv Surabhi produced higher fresh rhizome yield per clump (240.83 g), rhizome yield per plot (5.74 kg), and rhizome yield per hectare (19.12 t) which was statistically on par with Hui Local (237.64 g), rhizome yield per plot (5.71 kg), and rhizome yield per hectare (18.99 t), while Moran Ada produced the lowest rhizome yield per clump (108.71 g), rhizome yield per plot (2.50 kg), and rhizome yield per hectare (9.77 t). However, the highest rhizome yield per plant was recorded in Gorubathan with 201 g under West Bengal conditions (Chongtham *et al.* 2013). In the present investigation, the genotypes Thinglaidum, Gorubathan, Nadia and Khasi Local produced fresh rhizome yields of 227.76 g, 235.38 g, 215.02 g and 199.92 g per clump respectively. Such findings to yield per clump were contrary to those reported by Parshuram *et al.* (2016), where a higher fresh rhizome yield per plant was recorded in genotypes PGS-36 (450 g), followed by S-692 (413 g) and Tura Local (370 g) under Eastern Ghats High Land Zone of Odisha.

Chakraborty *et al.* (2018) reported that genotype GCP-49 produced the highest rhizome yield per plot (11.19 kg) over the local check variety Gorubathan (4.00 kg). However, the present study showed that Gorubathan produced 5.61 kg of fresh rhizome yield per plot. Chongtham *et al.* (2013) revealed that maximum fresh rhizome yield was observed in genotype Gorubathan (18.27 t/ha) and minimum in Himagiri (5.45 t/ha) under West Bengal conditions. Another report by Rani *et al.* (2019) reported that highest fresh rhizome yield was observed in Mahima (16.90 t/ha) over the check cultivar Nadia (14.36 t/ha) under Ranchi conditions. According to Jyotsna *et al*. (2012), Bhaisey recorded maximum yield (20.46 t/ha), followed by Gorubathan (19.13 t/ha) and Nadia (18.23 t/ha) under Manipur conditions. Sanwal *et al.* (2012) reported that highest rhizome yield was recorded in Nadia (23.28 t/ha) and also the rhizome yields of Nagaland Local (19.18 t/ha), Thinglaidum (18.42 t/ha), Tura Local (17.82 t/ha) and Khasi Local (14.76 t/ha) under Meghalaya conditions. Whereas, the present study showed that fresh rhizome yields of Gorubathan (18.38 t/ha), Thinglaidum (16.84 t/ha), Nadia (15.92 t/ha), Nagaland Local (11.26 t/ha), Tura Local (13.69 t/ha) and Khasi Local (15.31t/ha) under West Bengal conditions. Gorubathan recorded the maximum dry ginger yield (4.78 t/ha) which was closely followed by Surabhi (4.65 t/ha), Hui Local (4.43 t/ha), Thinglaidum (3.95 t/ha), Nadia (3.48 t/ha) and Thingpuri (3.35 t/ha), while the minimum dry yield was observed in Moran Ada (2.24 t/ha). The findings were supported by earlier studies in ginger evaluation (Goudar *et al.* 2017, Chongtham *et al.* 2013). Such variation in rhizome yield among ginger genotypes might be due to diverse soil and agroclimatic conditions in different collection areas as well as variations in cultural practices. It is also indicated that the local genotypes exhibit improved performance when subjected to the standard package of practices, which suggests a favorable interaction between specific genotypes, soil suitability and environmental factors in a particular region (Chongtham *et al.* 2013, Ravi *et al.* 2017).

CONCLUSION

The findings of the present study revealed that Surabhi, Gorubathan, Hui Local, Nadia, Thinglaidum, Thingpuri, and Banada Local exhibit superior performance and show great promise in terms of growth and yield attributes in new alluvial zone of West Bengal. Therefore, it is suggested that these genotypes can be utilized and recommended for further enhancement in commercial cultivation, as they have the potential to enhance the overall productivity of ginger crops.

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