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Evaluation of Ginger (*Zingiber officinale* Rosc.) Genotypes for Growth and Yield Attributes

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ABSTRACT

The field experiment was taken up to evaluate the ginger genotypes for growth and yield parameters at the Department of Plantation, Spices, Medicinal and Aromatic Crops, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka during 2015-2016. The genotype Humnabad Local was found superior among the twelve genotypes. Humnabad Local has recorded maximum plant height (56.60 cm), number of tillers per plant (24.33), number of leaves per plant (257.60) at 180 days after planting. It also has recorded highest fresh rhizome yield per plant (235.26 g), yield per plot (7.18 kg), yield per hectare (23.93 t/ha), dry rhizome yield per hectare (6.29 t/ha) and dry recovery percentage (26.32 %). Hence, Humnabad Local performed best among the genotypes evaluated.

Key words: *Ginger genotypes, Growth, Yield, Evaluation, Rhizome*

INTRODUCTION

India is known as the land of spices from the time immemorial and has been the leading country in the world for production, consumption and export of spices. Ginger (*Zingiber officinale* Rosc.) is one of the oldest known spices valued for its aroma and pungency. Ginger is used both in fresh and dried form. It is utilised widely as spice, for pickles, candies and as a medicinal herb for the treatment of gastrointestinal diseases, including dyspepsia, nausea and diarrhea.

India occupies an unique position of being the largest producer and exporter of ginger in the world. Indian ginger popularly known as cochin ginger, mainly comes from kerala is known for its quality in the world market. In India, it is grown in an area of 1,32,620 ha with an annual production of 6,55,060 MT and productivity of 4.9 MT/ha (Anon, 2014). Among the states, Orissa occupies 11.94 percent of total area and Assam is the largest producer with 18.67 percent of total production of the country. The average productivity of the crop at present is very low (4.9 MT per ha). There is tremendous scope to increase the yield per unit area and there by the total production.

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A good amount of genetic variability has been reported among different varieties with regard to growth, yield and quality parameters under different agro-climatic conditions. Several cultivars of ginger are grown in different ginger growing areas in India. They are generally named after the localities or place where they are grown. These local cultivars are selected, domesticated and planted for a long time under local natural conditions. They generally have greater adaptability, higher yield, better quality and unique use value. The available germplasm serves as most valuable natural reservoir for providing donor parent to improve the particular trait[4]. Therefore, collection, conservation and evaluation of germplasm are essential for present as well as future crop improvement programmes.

MATERIAL AND METHODS

The field experiment was taken up to evaluate ginger genotypes for growth and yield parameters at the Department of Plantation, Spices, Medicinal and Aromatic Crops, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka during 2015-2016. The thirteen ginger genotypes were laid out in Completely Randomized Block Design, replicated thrice. The land was brought to fine tilth by repeated ploughing and harrowing. Ginger varieties were planted in raised bed of 3.00 m length, 1.0 m width and 15 cm height during the june month. Seed rhizomes having 3 to 4 buds weighing about 20-25g were treated with mancozeb (3g/l), Chloropyrifos (4 ml/litre) and Streptomycin sulphate (0.5g/litre) solution for half an hour and dried in shade for twelve hours. Treated rhizomes were planted in the beds at 3.5 to 4.0 cm depth at a distance of 30 cm between rows and kept at 20 cm apart. The land was applied with FYM (25 t/ha) and recommended dose of P and K (50:50 kg P and K/ha) at the time of land preparation. Recommended N was applied in split doses, 50 percent of the N was applied one month after the planting and remaining 50 percent of the N was applied one month after the first application. Cultivation practices were followed as per recommended package of practices. The crop was harvested when leaves started withering by digging out the rhizomes after drying up of leaves which indicated complete maturity. Harvested rhizomes were cleaned to remove adhering soil and sticking roots. Observations were recorded for different growth and yield parameters on five randomly selected plants in each treatment of different replication.

The harvest index was calculated on dry weight basis by dividing weight of rhizome per clump with total weight of biomass produced per clump, as per the formula given by Donald (1962) and expressed in percentage.

$$\text{HI (\%)} = \frac{\text{Economic yield (g/plant)}}{\text{Biological yield (g/plant)}} \text{x } 100$$

The dry ginger recovery was measured by soaking known quantity of fresh rhizomes in water for 6 hours and adhering scales were removed, and the rhizomes were dried until constant weight was obtained and expressed in percentage. Dry ginger recovery in percentage was calculated using the formula.

$$\text{Percentage of dry ginger recovery} = \frac{\text{Weight of the dried ginger}}{\text{Weight of fresh ginger}} \text{ X } 100$$

The cured rhizome yield was obtained by multiplying the fresh rhizome weight with the average curing percentage and expressed in tones per ha. Duration from the date of planting to the date when more than sixty percent of the clumps in a treatment (genotype) showed withering and drying of foliage was accounted to days taken for maturity and expressed in days.

RESULT AND DISCUSSION

The data on growth parameters showed significant variation among the genotypes (Table 1). The plant height varied from 38.03

to 56.60 cm. It was maximum in genotype Humnabad Local (56.60 cm), which was on par with Rajatha (53.25 cm), Bidar-2 (53.20 cm) and Bidar-1 (50.10 cm). This is comparable with the findings of earlier workers, where in genotype Humnabad Local recorded plant height of 54.50 cm [6] and 45.20 cm [7]. The variations in plant height among the ginger genotypes was reported by Sangeetha and Subramanian[9] which ranged from 43.5 cm to 60 cm under Coimbatore conditions. Number of tillers per plant varied significantly from 10.01 in Himachal to 24.33 in genotype Humnabad Local.

The number of leaves per clump is important, as it is a source of carbohydrate production which is utilized for buildup of new cells. This leads to better growth, absorption of nutrients and ultimately increase in production of fresh and dry weight of plants. Significantly Maximum number of leaves per clump was recorded in the genotype Humnabad Local (257.60) on par with Bidar-2 (242.93) and Rajatha (226.90), while genotype Himachal recorded lowest number of leaves (118.70). The number of leaves ranged between 60.15 in ZO-12 to 148.16 in ZO-26 (Sangeetha and Subramanian, 2015). The stem girth varied between 0.88 cm in Suruchi to 1.21 cm in Humnabad Local.

Yield of any crop largely depends on the vigour of the plant as indicated by various growth parameters like plant height, number of leaves, number of tillers etc. Better growth is normally reflected through higher yield and the growth is governed by the genetic constituent of the variety and environmental condition under which the crop is raised. When different varieties are grown under identical conditions it is genetic factor that expresses the morphological differences.

Table 1: Growth parameters in ginger genotypes at 180 days after planting

Sl. No.	Genotypes	Plant height (cm)	Number of tillers per plant	Number of leaves per plant	Stem girth
1	Varada	38.03	13.50	125.80	0.95
2	Mahima	48.33	14.70	131.30	1.15
3	Rajatha	53.25	21.45	226.90	1.18
4	Suprabha	47.77	14.60	145.13	1.02
5	Suravi	49.03	18.50	168.30	1.02
6	Himagiri	46.90	15.60	194.97	1.10
7	Himachal	39.13	10.01	118.70	0.90
8	Jorhat-2	46.43	18.60	165.70	0.93
9	Bidar-1	50.10	20.40	203.37	1.01
10	Bidar-2	53.20	22.27	242.93	1.12
11	Humnabad Local	56.60	24.33	257.60	1.21
12	Suruchi	47.37	19.50	178.23	0.88
	S. Em±	2.30	1.44	11.67	0.06
	C.D. (5 %)	6.73	4.24	34.23	0.17
	CV (%)	8.28	14.07	11.24	9.66

All the yield contributing characters varied significantly among the ginger genotypes (Table 2). Number of primary rhizome ranged from 3.15 to 6.20. Maximum number of primary rhizome was observed in Humnabad Local (6.20) which was on par with Rajatha (5.90), Bidar-2 (5.60) and Mahima (5.20) while minimum was observed in Himachal (3.15). Length of primary rhizome ranged between 2.52 cm in Suravi to 4.9 cm in Humnabad Local. Significantly maximum girth of primary rhizome was recorded in Rajatha (2.04 cm) and minimum girth of primary rhizome was recorded in Himachal (1.45 cm).

Number of secondary rhizome was maximum in var. Humnabad Local (16.32) on par with Rajatha (15.67), Bidar-2 (15.26), Suruchi (14.26) and Mahima (13.82) while, minimum was recorded in Himachal (9.25). Length of the secondary rhizome was highest in var. Humnabad local (4.73 cm). While Suruchi recorded lowest length of secondary rhizome (2.61 cm)**.** Girth of secondary rhizome ranged between 1.38 cm in Himachal to 1.86 cm in Rajatha. Rajyalakshmi and Umajyothi (2014) reported maximum number of finger rhizomes in Suprabha (11.7) and Chinthapalli Local (11.33) and minimum number of fingers was recorded in ACC-35 (7.60). Chongatham *et al*. (2013) recorded the length of primary rhizome ranging from 3.01 cm in Suruchi to 3.53 cm in Varada. Whereas, the cultivar Gourabathan Local recorded the highest primary rhizome diameter (2.28 cm).

Data on yield parameters varied significantly among the genotypes (Table3). Fresh yield per plant ranged from 121.67 g to 235.26 g. The highest fresh yield per plant was recorded in var. Humnabad Local (235.26 g) which was on par with Rajatha (217.32 g), Mahima (211.67 g) and Himagiri (206.45 g), while it was lowest in Himachal (121.67 g). Fresh yield per hectare ranged from 12.32 t/ha to 23.93 t/ha. The maximum yield per hectare was recorded in Humnabad Local (23.93 t/ha) which was on par with Rajatha (21.63 t/ha). The minimum fresh yield was recorded in Himachal (12.32 t/ha).

The results are in line with the findings of Kale *et al*.[6] and Kurubar *et al*.[7] who reported the highest fresh yield in Humnabad Local (28.45 t/ha and 24.42 t/ha, respectively). Jyotsana *et al*.[5] reported highest rhizome yield in Bhaisey (20.46 t/ha) under Imphal conditions. Chongtham *et al*.[2] recorded the highest rhizome yield per hectare (18.27 t/ha) in local cultivar Gorubathan, followed by another local cultivar Sambuk (14.74 t/ha) in Southern West Bengal. Rajyalakshmi and Umajyothi[8] recorded highest fresh rhizome yield in Suprabha (21.71 t/ha). Sangeetha and Subramanian[9] reported the fresh rhizome yield ranging from 5.33 t/ha to 28.62 t/ha under Coimbatore conditions.

Percentage of dry ginger recovery ranged from 18.47 to 26.32. The maximum dry ginger recovery was noticed in var. Humnabad Local (26.32 %) which was on par with Rajatha (24.95 %), Mahima (24.17 %), Himagiri (22.65 %) and Suravi (22.56 %). The minimum dry ginger recovery was noticed in Bidar-1 (18.47 %). Dry ginger yield was maximum in genotype Humnabad Local (6.29 t/ha) on par with Rajatha (5.39 t/ha) and minimum was recorded in Himachal (2.52 t/ha). Similar findings were recorded by Kale[6] who reported the highest dry ginger yield in Humnabad Local (8.04 t/ha) and the lowest dry ginger yield in genotype Haveri (2.99 t/ha). Kurubar[7], Chongatham *et al*.[2].

The performance of genotypes revealed that the inherent capacity of the genotypes evaluated in similar conditions. The higher fresh rhizome yield in the genotypes Humnabad Local and Rajatha is attributed to the growth parameters like plant height, number of leaves per plant and number of tillers per plant. These high yielding genotypes recorded higher values for growth parameters and yield attributing characters *viz.,* number, length and girth of primary rhizomes and secondary rhizome which also contributed to higher yield.

Table 2: Yield contributing characters in ginger genotypes

Sl. No.	Genotypes	Number of primary rhizome	Length of primary rhizome (cm)	Girth of primary rhizome (cm)	Number of secondary rhizome	Length of secondary rhizome (cm)	Girth of secondary rhizome (cm)
1	Varada	4.32	2.75	1.57	12.16	2.63	1.50
2	Mahima	5.20	3.80	1.97	13.82	4.30	1.72
3	Rajatha	5.90	4.30	2.04	15.67	4.20	1.86
4	Suprabha	4.16	3.42	1.93	11.23	3.63	1.77
5	Suravi	3.62	2.52	1.67	10.30	2.78	1.52
6	Himagiri	4.25	4.20	1.89	11.72	3.80	1.72
7	Himachal	3.15	2.55	1.45	9.25	2.73	1.38
8	Jorhat-2	3.47	3.25	1.47	10.45	3.42	1.41
9	Bidar-1	4.56	3.70	1.50	13.73	3.45	1.44
10	Bidar-2	5.60	4.05	1.53	15.26	4.13	1.48
11	Humnabad Local	6.20	4.90	1.86	16.32	4.73	1.68
12	Suruchi	4.71	3.15	1.70	14.26	2.61	1.56
	S.Em±	0.42	0.34	0.08	0.87	0.35	0.07
	C. D. (5 %)	1.24	1.01	0.24	2.55	1.01	0.19
	CV (%)	15.96	16.81	8.42	11.71	16.96	7.18

Table 3: Rhizome yield as influenced by ginger genotypes

Sl. No	Genotypes	Fresh rhizome yield			Recovery (%)	Dry ginger yield (t/ha)
		Yield / plant (g)	Yield / plot (kg)	Yield / hectare (t/ha)		
1	Varada	152.45	4.48	14.95	20.65	3.08
2	Mahima	211.67	6.16	20.56	24.17	4.96
3	Rajatha	217.32	6.49	21.63	24.95	5.39
4	Suprabha	173.64	5.60	18.67	21.65	4.04
5	Suravi	187.58	5.05	16.83	22.56	3.79
6	Himagiri	206.45	5.93	19.76	22.65	4.47
7	Himachal	121.67	3.71	12.32	20.45	2.52
8	Jorhat-2	137.47	4.11	13.71	19.41	2.66
9	Bidar-1	158.76	5.24	17.45	18.47	3.22
10	Bidar-2	194.34	5.89	19.63	21.85	4.24
11	Humnabad Local	235.26	7.18	23.93	26.32	6.29
12	Suruchi	165.48	4.59	15.32	20.95	3.20
	S.Em±	12.20	0.42	0.99	1.45	0.35
	C. D. (5 %)	35.77	1.23	2.91	4.25	1.02
	CV (%)	11.72	13.52	9.59	11.40	15.12

The harvest index in ginger genotypes is given in the Table 4. Harvest index differed significantly among the varieties. The genotype Humnabad Local recorded the maximum harvest index of 59.30 %, which was on par with Rajatha (57.46 %), Mahima (55.47 %), Himagiri (55.43 %) and Bidar-2 (53.54 %). The least harvest index was recorded in the genotype Himachal (45.26 %). Kurabar[7] reported the highest harvest index in cv. Rio-de-Janeiro (64.03%) followed by Humnabad Local (63.23 %). The number of days taken from planting to harvesting differed significantly among the genotypes. The crop duration ranged from 205 days (Varada) to 240 days (Bidar-1). The genotype Bidar-1 recorded longer crop duration (240 days) and was on par with Humnabad Local (235 days), Suprabha (231 days) Himagiri and Bidar-2 (230 days), while genotypes Varada (205

days), Mahima (207 days), Rajatha (213 days) and Jorhat-2 (216 days) took less number of days to mature (Table 4). Kale[6] observed crop duration ranging from 190 days to 225 days. Kurubar[7] reported variation in crop duration ranging between 200-241 days.

Table 4: Harvest index and crop duration in ginger genotypes

Sl. No.	Genotypes	Harvest index (%)	Crop duration (Days)
1	Varada	46.57	205.00
2	Mahima	53.68	207.00
3	Rajatha	52.91	213.00
4	Suprabha	49.04	231.00
5	Suravi	47.51	218.00
6	Himagiri	49.87	230.00
7	Himachal	43.33	218.00
8	Jorhat-2	38.11	216.00
9	Bidar-1	31.45	240.00
10	Bidar-2	42.35	230.00
11	Humnabad Local	55.69	235.00
12	Suruchi	41.69	217.00
	S.Em±	2.02	7.17
	C. D. (5 %)	5.92	21.03
	CV (%)	7.59	5.6

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