

Yield and yield attributes in ginger (*Zingiber officinale* Rosc.) somaclones for quality seed production

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Abstract— The experiment was taken up to elicit the information on the performance of different ginger (*Zingiber officinale* Rosc.) somaclones for yield and quality for quality seed production. Ten somaclones of ginger were evaluated in RBD with three replications during 2015-18 at College of Horticulture, Kerala Agricultural University, Thrissur district, Kerala. The growth performance of ten somaclones indicated significant variation at all the stages of crop growth. Among the somaclones, SE 86102 (16.00 days) and SE 8626 (16.33 days) registered least number of days for sprouting. Among the vegetative characters studied, the maximum plant height (107.38 cm) was recorded by the somaclone SE 86102 which was significantly superior to other somaclones and check varieties. Somaclone CHP 118 recorded maximum number of tillers (20.33), number of leaves per shoot (28.67) and total number of leaves per shoot (117.33). The highest leaf area was recorded by C 8632 with a value of 62.12 cm². Among the rhizome characters recorded, the somaclone CHP 118 gave highest number of primary rhizomes (4.83) which was on par with SE 8626 (4.33) and C 8632 (4.08). The highest number of secondary rhizome was recorded by CHP 118 (10.33) which was on par with SE 8626 (10.06) and C 8632 (10.01). Weight of mother rhizome was the highest in the somaclone SE 8642 (11.00 g) and CHP 118 (10.67 g). Similarly, weight of primary rhizome was highest in SE 8642 (15.73 g), SE 8626 (15.07 g) and CHP 118 (14.80 g). Weight of secondary rhizome was highest in SE 8626 (13.20 g) and SE 8642 (12.33 g). The highest fresh rhizome yield per plant was recorded by somaclone CHP 118 (274.13 g), SE 8626 (266.67 g), C 8632 (259.67 g) and SE 8642 (251.67 g) at full maturity. The highest yield per plot was recorded by somaclone CHP 118 (8.77 kg), SE 86 26 (8.54 kg), C 8632 (8.31 kg) and SE 8642 (8.06 kg). The fresh rhizome yield per hectare was maximum in CHP 118 (35.08 t), SE 86 26 (34.16 t), C 8632 (33.24 t) and SE 8642 (32.24 t). It is concluded that somaclones were highly variable in their performance, yield and yield attributes. Four somaclones viz., CHP 118, SE 8626, C 8632 and SE 8642 were identified as high yielders from their outstanding performance throughout their growth period with highest yield in CHP 118. This can be due to more number of tillers, leaves per shoot and rhizomes and also weight of primary, secondary and mother rhizomes.

Keywords— *Ginger, Somaclones, Yield and Horticulture.*

I. INTRODUCTION

Ginger is an important commercial spice crop grown in India for its culinary and wide range of medicinal uses and is considered as an essential component of the kitchen pharmacy. It belongs to the family *Zingiberaceae*, native of South East Asia. It is a tropical and sub-tropical perennial herb 'generally recognized as safe' by the Food and Drug Administration (FDA) of the United States and has gained considerable attention as a botanical dietary supplement in developed countries, opening ample export potential. Somaclonal variations act as a major source of variability for crop improvement in ginger (Shylaja *et al.*, 2010 and Dev, 2013). Evaluation of somaclones derived from two polyploids (Z-0-78 and Z-0-86) and a triploid cultivar Himachal Pradesh (generated through indirect organogenesis and embryogenesis) indicated that somaclones are superior to conventionally propagated plants for various growth and yield parameters (Kurian, 2010). The present investigation was carried out with the objective of evaluating somaclones in ginger for variability in performance, yield and yield attributes for quality seed production.

II. MATERIALS AND METHODS

Somaclones developed through indirect methods of regeneration from two induced polyploids of ginger (Z-0-78 from 'Himachal Pradesh' treated with 0.25% colchicine by injection method and Z-0-86 from Rio-de-Janeiro treated with 0.1% colchicine by hole method) and diploid cultivar 'Himachal Pradesh' formed the base material for the study (Table 1). Ten such somaclones of ginger viz., SE 86 26, SE 86 83, C 86 26, CHP 118, C 78 284, SE 86 102, SE 86 42, C 86 32, CHP 99 and CHP 282 were selected for the study along with three check varieties (Rio- de -Janeiro, Himachal and Aswathy). The experimental site was located in the farm of Department of Plantation Crops and Spices, College of Horticulture, Thrissur, Kerala. The experiment was laid out in a Randomized Block Design with three replications in plot size 2.0 × 1.0 m² at the spacing of 25.0 cm × 25.0 cm. The field was prepared and planting was done in the last week of May and maintained as per

Package of practice recommendations of Kerala Agricultural University (KAU, 2011). Five plants per replication were selected at random and studied for growth characters. The crop was harvested at full maturity, indicated by withering of above ground parts. The harvested rhizomes were cleaned after removing roots and rhizome characters were recorded. The fresh rhizome yields per plant and per plot were recorded and per hectare yield was computed.

TABLE 1
DETAILS OF SOMACLONES SELECTED FOR THE STUDY

Somaclones	Parents	Mode of regeneration
C 86 26	Z-0-78	Indirect organogenesis
C 86 32		
C 78 284	Z-0-86	
CHP 282	Himachal	
CHP 118		
CHP 99		
SE 86 83	Z-0-86	Indirect embryogenesis
SE 86 26		
SE 86 42		
SE 86 102		

III. RESULTS AND DISCUSSION

3.1 Plant characters

Ten ginger somaclones and three check varieties exhibited variation in number of days for sprouting and plant characters viz., plant height, number of tillers, number of leaves per shoot, and leaf area (Table 2).

TABLE 2
MORPHOLOGICAL CHARACTERS OF GINGER SOMACLONES AT 6 MONTH STAGE

Somaclones	Number of days for sprouting	Plant height (cm)	Number of tillers per plant	Number of leaves per shoot	Total no. of leaves per plant	Leaf area (cm ²)
SE 86 26	16.33	87.37	18.01	28.33	108.33	55.14
SE 86 83	16.67	84.50	15.63	17.25	104.00	48.08
C 8626	23.33	85.47	14.83	16.43	100.77	43.60
CHP 118	18.67	90.34	20.33	28.67	117.33	51.74
C 78 284	18.33	75.42	15.27	21.00	100.97	50.63
SE 86 102	16.00	107.38	15.13	18.23	98.84	42.09
SE 86 42	20.67	80.20	17.97	26.33	108.11	58.46
C 86 32	18.33	87.55	16.93	26.07	107.33	62.12
CHP 99	23.67	82.02	11.23	16.87	86.44	37.43
CHP282	21.00	92.23	15.01	16.93	104.67	52.56
Rio-de-Janeiro	16.33	83.52	11.56	17.89	95.167	41.38
Himachal	15.33	92.07	11.43	17.88	95.20	41.88
Aswathy	13.67	72.55	14.93	20.20	97.69	43.25
CD (0.05)	2.71	5.52	0.83	1.77	10.85	2.96

Early sprouting was observed in all the three check varieties and also in the somaclones SE 86102 (16.00 days) and SE 8626 (16.33 days). Released variety Aswathy took only 14 days for sprouting whereas, C 8626 and CHP 99 took 23 days to sprout. Shadap *et al.* (2013) have reported similar result confirming early and complete sprouting in a shorter period when ginger is planted in May and June.

Plant height of ginger somaclones varied between 72.42 to 107.38 cm. The somaclone SE 86102 recorded the highest plant height (107.38 cm) which was significantly superior to other somaclones and check varieties. The lowest plant height was recorded in C 78284 (75.42 cm) and Aswathy (72.55 cm). Similar variability in plant height of ginger somaclones was reported by Iwo *et al.* (2011) and Dev (2013).

The number of tillers per plant varied significantly among ginger somaclones. The somaclone CHP 118 recorded the highest values for number of tillers per plant (20.33) followed by SE 8626 (18.01) and SE 8642 (17.97) and the lowest number of tillers was observed in CHP 99 (11.23) and the check varieties Himachal (11.43) and Rio- de –Janeiro (11.56). Variability in number of tillers in ginger genotypes was reported by Dev *et al.* (2016) and Surendrababu *et al.* (2017).

The number of leaves per shoot among the somaclones varied between 16.43 to 28.67. The somaclone CHP 118 recorded the highest number of leaves per shoot (28.67) and was on par with SE 8626 (28.33). Lowest number of leaves per shoot was observed in the somaclones C 8626 (16.43) followed by CHP 99(16.87) and CHP 282 (16.93). Karthik *et al.* (2017) reported that the number of leaves per tiller ranged from 12.02 (T9- Acc-723) to 20.07 (T5-Acc-219) among the different germplasm studied. At 6 MAP, total number of leaves per plant ranged from 86.44 (CHP 99) and 117.33 (CHP 118). CHP 118 recorded maximum number of leaves per plant (117.33) and was on par with SE 8626 (108.33), SE 8642 (108.11) and C 8632 (107.33). Number of leaves increased with growth stages upto 6 month of planting and later decreased

Leaf area influences the photosynthetic efficiency of plants. The somaclone C 8632 recorded the highest leaf area (62.12 cm²) at six month stage followed by SE 8642 (58.46 cm²) and SE 8626 (55.14cm²). These results are comparable with the findings of Surendrababu *et al.* (2017), where the leaf area per plant in ginger varieties ranged from 22.88 cm² to 32.47 cm² which might be due to the differences in leaf length and width as the age of the plant advances and due to environmental conditions.

3.2 Rhizome characters

Variability in rhizome characters such as number of primary and secondary rhizomes, weight of mother rhizome, weight of primary and secondary rhizomes and rhizome yield per plant, plot and hectare observed at full maturity is presented in Table 3. There was significant difference among the somaclones on the number of primary rhizomes and the highest value (4.83) was recorded by the CHP 118 and was on par with SE 8626 (4.33) and C 8632 (4.08). The number of secondary rhizomes was also found maximum for CHP 118 with a value of 10.33 and was on par with SE 8626 (10.06) and C 8632 (10.01). The weight of mother rhizome varied from 5.60 to 11.00 grams in the study recording the highest value (11.00 g) in the somaclone SE 86 42 which was on par with CHP 118 (10.67g). Lowest mother rhizome weight (5.60 g) was recorded in Rio-de-Janeiro. The average weight of primary rhizome showed significant variation among the somaclones and the highest value (15.73 g) was recorded for SE 8642 and was on par with SE 8626 (15.07 g) and CHP 118 (14.80 g) followed by C 8632 (14.01 g). SE 86102 recorded lowest value (8.10 g) for this character. The highest value (13.20 g) for secondary rhizome was recorded for SE 8626 which was on par with SE 86 42 (12.33 g) and the lowest was for CHP 282 (6.33 g). Such variation with respect to rhizome characters has been reported earlier by Chongtham *et al.*, (2013) and Dev (2013).

TABLE 3
RHIZOME CHARACTERS OF GINGER SOMACLONES

Somaclones	Number of fingers		Weight of fingers (g)			Fresh yield	
	Primary	Secondary	Mother	Primary	Secondary	Yield / plant (g)	Yield / plot (kg)
SE 86 26	4.33	10.06	9.67	15.07	13.20	266.67	8.54
SE 86 83	3.33	7.33	7.43	11.40	8.20	145.33	4.65
C 8626	3.33	6.33	8.10	10.47	7.47	201.93	6.48
CHP 118	4.83	10.33	10.67	14.80	11.21	274.13	8.77
C 78 284	3.01	8.67	8.80	11.07	8.43	209.67	6.51
SE 86 102	2.98	7.67	6.03	8.10	7.42	176.47	5.65
SE 86 42	3.98	8.33	11.00	15.73	12.33	251.67	8.06
C 86 32	4.08	10.01	9.23	14.01	10.40	259.67	8.31
CHP 99	2.52	6.00	7.90	11.13	7.10	131.53	4.21
CHP282	3.33	6.00	6.27	11.30	6.33	206.27	6.60
Rio-de-Janeiro	3.67	8.33	5.60	11.28	8.87	196.67	6.29
Himachal	3.33	8.67	7.83	10.43	9.10	187.73	6.01
Aswathy	3.42	8.67	7.80	11.43	8.17	201.20	6.43
CD (0.05)	0.75	1.22	0.52	1.25	1.08	29.71	1.05

Significant difference was observed among somaclones for yield characters recorded at full maturity stage (Table 3). The highest fresh rhizome yield per plant (274.13 g) was recorded by somaclone CHP 118 which was on par with SE 8626 (266.67 g), C 8632 (259.67g) and SE 8642 (251.67 g) at harvest. The highest yield per plot (8.77 kg) was recorded by somaclone CHP 118 and was on par with SE 86 26 (8.54 kg), C 8632 (8.31 kg) and SE 8642 (8.06 kg). Per hectare yield was found maximum for the somaclone CHP 118 (35.08 t), SE 86 26 (34.16 t), C 8632 (33.24 t) and SE 8642 (32.24 t) compared to other somaclones and check varieties (Fig 1). The higher yield obtained in these ginger somaclones were due to higher number of tillers and rhizomes and also due to higher weight of rhizomes. The rhizome yield of ginger is an outcome of good rhizome characters such as number and weight of primary, secondary and mother rhizomes as reported by Sangeetha and Subramanian (2015). In the present study, 60 per cent of the somaclones yielded higher than check varieties and the highest yield increase was 40 percentage. This is also in accordance with the study of Kankanawadi (2015) who reported variability in rhizome yield in ginger somaclones. Superiority of somaclones over conventionally propagated plants for rhizome characters and yield was reported by Dev (2013) and Resmi and Shylaja (2012).

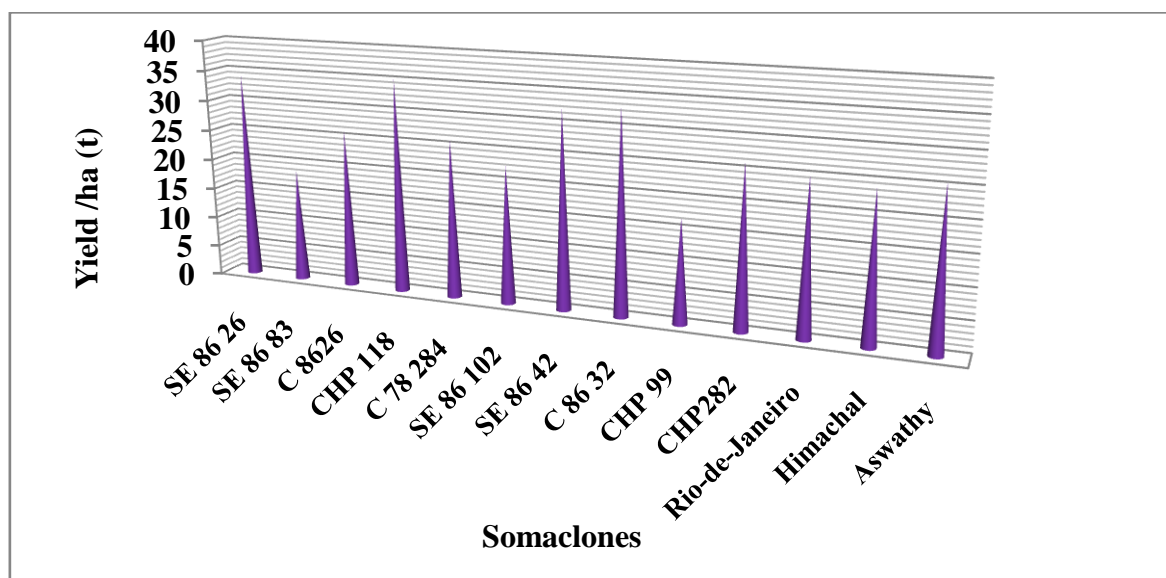


FIG 1. Yield of ginger somaclones (t/ha)

IV. CONCLUSION

The present study concluded that somaclones were highly variable in their performance, yield and yield attributes. Among the somaclones studied, CHP 118 showed significant performance followed by SE 8626, C 8632 and SE 8642 with respect to growth and yield parameters compared to other somaclones and check varieties. They can be rated as the best since they possess the higher rhizome yield and found suitable for cultivation and seed production in Kerala condition. Yield contributing attributes may be taken care of in selecting variety for high yield.

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