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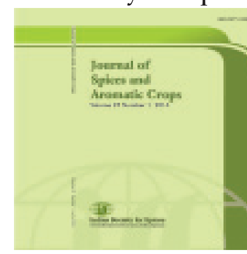

Yield attributes and yield in somaclones of ginger (*Zingiber officinale* Rosc.)

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Abstract

Twenty five somaclones derived from two induced polyploids (Z-0-78 and Z-0-86) and diploid cultivar '*Himachal Pradesh*' were field evaluated and subjected to yield and yield attribute analyses. Somaclones were highly variable in the yield and yield attributes. Extent of variation was more in somaclones when compared to check varieties (*Karthika* and *IISR-Varada*) rather than parent cultivars (Z-0-78, Z-0-86 and HP). Somaclones derived from Z-0-86 recorded superiority in rhizome characters over those derived from 'Himachal Pradesh' and Z-0-78. About 92% of somaclones showed higher yield over parent cultivars while 84% of somaclones showed higher rhizome yield over check varieties. Somaclones derived from Z-0-86 alone recorded higher driage and dry yield.

Keywords: ginger, somaclones, yield and yield attributes

Introduction

Ginger (*Zingiber officinale* Rosc.), one of the most renowned spices of the *Zingiberaceae* family, is widely cultivated for its aromatic and pungent rhizome which is used as spice, vegetable and medicine. Extant ginger cultivars are uniformly susceptible and conventional breeding methods are ineffective, because it is obligatory asexual is propagated exclusively through rhizomes. Conventional breeding techniques like evaluation of germplasm and selection, induction of variability by mutagenesis and colchiploidy, though found promising, could not tackle these problems to an appreciable extent. Exploitation of *in vitro* culture induced variation or somaclonal variation as a method to create variability is unique. Somaclonal variation, as a method to create variability has been effectively utilized for improving yield in a variety of zingiberaceous crops including ginger (Paul 2006; Shylaja *et al*. 2003; Kurian 2010), turmeric (Roopadarsini & Gayatri 2012), kacholam (Geetha *et al*. 1997; Joseph 1997), small cardamom (Reghunath 1989; Lukose *et al.*1993; Reghunath & Priyadarshan 1993; Kuruvila *et al.* 2005) and large cardamom (Rao *et al*. 2003). The present investigation was carried out with the objective of evaluating somaclones in ginger for variability in yield and yield attributes.

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). Twenty five somaclones selected from among 289 somaclones based on preliminary screening were field planted along with two check varieties (*Karthika* and *IISR-Varada*) and three parental cultivars (Z- 0-78, Z-0-86 and HP) and evaluated for variation in yield and yield attributes in Randomised Block Design with two replications. Each beds of size 2 m × 1 m contained 32 plants. Yield attributes were recorded when the crop was harvested at full maturity, indicated by withering of above ground parts. Ten single plant rhizomes were taken at the time of harvest from each replication to record observations and average of replications was calculated. The harvested rhizomes were cleaned after removing roots and yield attributes like number of primary, secondary, tertiary fingers and quaternary fingers, length of primary and secondary fingers, girth of primary and secondary fingers and internodal length were recorded. The fresh rhizome yield plant^{-1} and plot^{-1} recorded and ha^{-1} yield was computed. One kilogram of fresh rhizome was rough peeled and sun dried till a constant weight was obtained to work out driage percent. The ha^{-1} yield of dry rhizomes (tonnes) was computed from the ha^{-1} fresh yield and driage per cent.

Results and discussion

Somaclones exhibited significant variations compared to parent cultivars and check varieties in various characters studied. Somaclones showed superiority over parent cultivars in length and inter-nodal length of primary fingers and quaternary fingers while superiority over check varieties was seen for girth of rhizome, number of quaternary, secondary and tertiary fingers (Table 2 and Figs. 1 & 2). All the somaclones showed increase in length of primary and internodal length of primary fingers over parent cultivars and per cent increase was maximum for internodal length of primary followed by number of quaternary and length of primary. Compared to check varieties, all the somaclones recorded higher rhizome girth but maximum increase was noticed for number of quaternary followed by number of secondary and tertiary fingers. With respect to number of primary, the increase was more compared to parents than check varieties. Babu (1997) and Paul (2006), and Salvi *et al.* (2002) have earlier reported similar observations on superiority of somaclones in

Table 1. Details of somaclones selected for the study

Parent	Somaclones	Mode of regeneration
Z-0-78	C 78 129	Indirect organogenesis
Z-0-86	C 86 23	
	C 86 26	
	C 86 32	
	C 86 40	
	C 86 124	
	C 86 139	
Himachal Pradesh	CHP 8	
	CHP 39	
	CHP 49	
	CHP135	
Z-0-78	SE 78 26	Indirect embryogenesis
	SE 78 30	
Z-0-86	SE 86 24	
	SE 86 40	
	SE 86 42	
	SE 86 81	
	SE 86 83	
	SE 86 131	
	SE 86 142	
Himachal Pradesh	SEHP 8	
	SEHP 63	
	SEHP 64	
	SEHP 73	
	SEHP 146	

Table 2. Rhizome characters of somaclones in ginger

Somaclones/ parents/ check	No. of fingers				Length of fingers (cm)		Internodal length of fingers (cm)	
	1^0	2^0	3^0	4^0	1^0	2^0	1^0	2^0
CHP 8	4.20	11.30	13.70	4.35	4.81	3.83	0.82	0.66
CHP 39	4.10	8.20	8.80	4.92	5.13	4.16	0.72	0.61
CHP 49	3.40	10.00	9.90	6.44	4.93	3.86	0.80	0.60
CHP 135	4.00	10.50	11.00	5.10	4.82	4.00	0.79	0.68
SEHP 8	3.70	10.40	10.40	6.78	4.57	3.36	0.74	0.60
SEHP 63	3.40	9.10	12.00	8.85	5.14	4.77	0.89	0.72
SEHP 64	4.10	9.80	6.80	2.55	4.33	2.92	0.80	0.54
SEHP 73	4.10	8.10	6.80	3.58	4.55	4.03	0.79	0.64
SEHP 146	3.50	7.70	9.40	4.35	4.98	3.16	0.74	0.62
C 78 129	2.40	5.20	5.60	7.80	4.17	3.30	0.91	0.63
SE 78 26	3.90	10.40	9.20	3.38	4.07	3.23	0.85	0.62
SE 78 30	4.10	7.90	6.70	2.13	4.17	2.99	0.77	0.67
C 86 23	4.00	12.00	12.30	4.70	5.57	4.06	0.94	0.65
C 86 26	3.40	8.90	11.70	8.00	4.35	3.94	0.91	0.68
C 86 32	3.20	3.70	3.55	1.50	3.92	3.52	0.67	0.58
C 86 40	3.40	8.30	11.90	4.93	4.86	3.87	0.79	0.62
C 86 124	3.50	7.90	10.40	9.80	3.88	3.33	0.69	0.66
C 86 139	3.70	7.80	9.80	5.00	4.48	3.69	0.74	0.69
SE 86 24	3.50	6.40	7.45	3.00	3.85	2.66	0.71	0.54
SE 86 40	4.10	9.90	13.20	5.18	4.92	4.37	0.91	0.71
SE 86 42	3.50	9.30	10.40	5.25	5.08	3.65	0.90	0.70
SE 86 81	2.70	7.80	9.00	3.85	5.26	4.38	0.92	0.63
SE 86 83	3.40	7.70	9.10	4.60	5.22	3.87	0.92	0.63
SE 86 131	3.10	9.40	15.38	6.33	4.73	3.68	0.97	0.69
SE 86 142	3.40	11.10	13.10	7.30	4.48	4.09	0.81	0.73
Karthika	3.80	4.90	7.40	1.80	3.89	3.71	0.70	0.63
IISR-Varada	3.00	6.17	6.84	1.50	3.85	2.99	0.66	0.55
Z-0-78	2.90	7.00	6.55	3.20	2.98	3.31	0.42	0.32
Z-0-86	3.30	8.08	9.39	4.94	3.24	4.05	0.38	0.39
HP	3.73	9.55	10.04	5.11	3.35	3.50	0.58	0.64
C D ($P<0.05$)	1.21	4.93	9.54	5.62	1.82	0.98	0.27	0.17
C V (%)	13.93	24.83	44.49	57.25	12.58	11.46	16.36	12.71

1^0-Primary fingers, 2^0-Secondary fingers, 3^0-Teritiany fingers, 4^0-Quatenary fingers

Contd…

Table 3. Rhizome characters and yield of somaclones in ginger

Variety	Thickness of fingers (cm)		Thickness of core(cm)		Girth of 1^0 fingers (cm)	Fresh yield (t ha^{-1})	Dry yield(t ha^{1-})
	1^0	2^0	1^0	2^0			
CHP 8	3.06	3	1.58	1.56	8.65	17.34	2.97
CHP 39	2.9	2.57	1.70	1.33	8.77	15.76	2.69
CHP 49	3.21	2.87	1.69	1.59	8.67	15.68	2.58
CHP 135	3.09	2.56	1.77	1.24	8.97	17.04	2.71
SEHP 8	3.21	2.6	1.73	1.40	8.94	16.62	3.11
SEHP 63	2.97	2.79	1.73	1.63	8.08	19.31	3.21
SEHP 64	2.73	2.42	1.49	1.26	8.33	11.73	2.23
SEHP 73	2.98	2.76	1.62	1.40	8.81	13.15	2.19
SEHP 146	2.45	2.6	1.25	1.28	7.33	9.81	1.71
C 78 129	2.61	2.39	1.37	1.27	7.50	10.99	2.12
SE 78 26	2.91	2.68	1.63	1.36	7.90	14.64	3.08
SE 78 30	2.71	2.5	1.51	1.26	8.18	14.27	2.95
C 86 23	2.68	2.63	1.36	1.31	7.89	17.98	3.09
C 86 26	2.55	2.72	1.23	1.44	7.50	17.36	2.89
C 86 32	2.5	2.11	1.42	1.23	7.34	14.35	3.07
C 86 40	2.79	2.79	1.47	1.39	7.85	18.19	3.50
C 86 124	2.33	2.16	1.25	1.12	7.40	16.00	3.28
C 86 139	2.72	2.67	1.36	1.39	7.96	17.95	3.59
SE 86 24	2.54	2.28	1.30	1.16	7.87	11.97	2.13
SE 86 40	2.87	2.85	1.43	1.47	7.94	19.82	3.69
SE 86 42	2.8	2.76	1.32	1.52	8.01	14.27	2.79
SE 86 81	2.28	2.04	1.20	1.04	7.11	21.42	3.75
SE 86 83	2.6	2.55	1.40	1.43	7.53	17.68	3.17
SE 86 131	2.95	2.63	1.71	1.35	7.78	18.14	3.22
SE 86 142	2.62	2.39	1.38	1.19	7.72	20.00	3.92
Karthika	2.3	2.39	1.42	1.07	6.80	11.87	2.40
IISR-Varada	2.34	1.87	1.34	1.40	7.08	13.12	2.66
Z-0-78	2.56	2.6	1.32	1.22	7.09	10.58	2.34
Z-0-86	2.52	2.38	1.32	1.18	5.97	11.55	2.19
HP	2.94	2.36	1.54	1.34	7.87	13.01	2.76
C D ($P<0.05$)	0.66	0.77	0.44	0.22	1.33	5.90	1.27
C V (%)	11.23	13.00	10.74	15.57	7.48	17.56	20.18

1^0-Primary fingers, 2^0-Secondary fingers

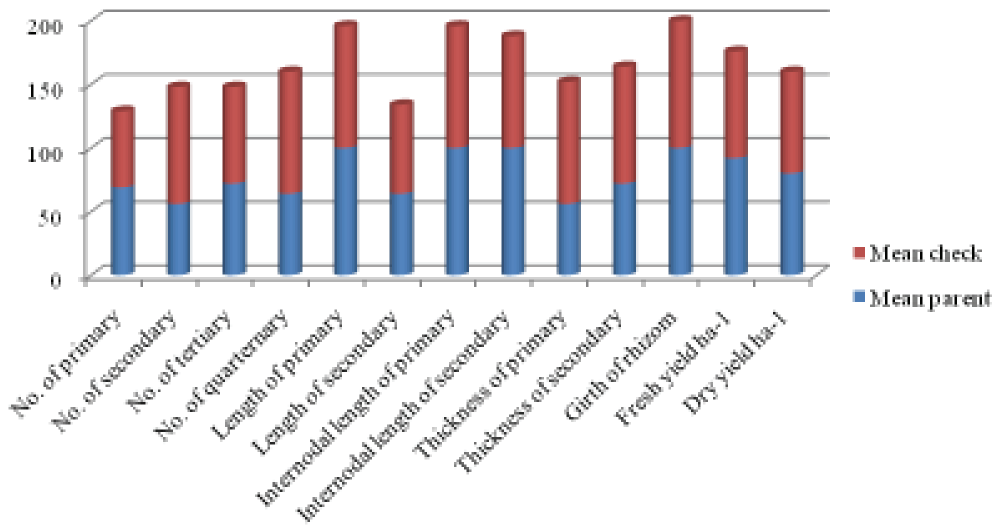

Fig. 1. Per cent of maximum increase in rhizome characters of somaclones in relation to mean parent and check variety

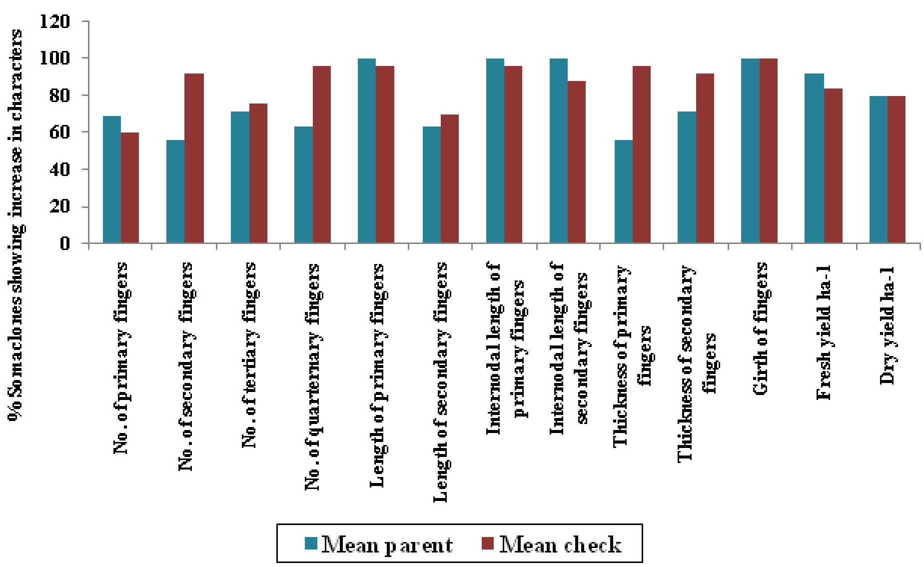

Fig. 2. Per cent of somaclones showing increase in rhizome characters over mean parent and check variety

yield contributing rhizome characters over parent and check varieties in ginger and turmeric somaclones.

Among the different rhizome characters, number of quaternary fingers recorded the highest increase of 105% over parent cultivars and 498% over check varieties. Somaclone C 86 124 recorded the highest number of quaternary fingers while C 86 23 had the highest length of primary fingers. Somaclone SE 86 131 recorded the highest internodal length of primary fingers. Variability in yield contributing characters in somaclones of spice crops was reported by Chandrappa *et al.* (1997), Sudharshan *et al.* (1997) and Sudharshan & Bhat (1998) in cardamom and Sanchu *et al.* (2000) in black pepper somaclones. Somaclones derived from Z-0-86 recorded maximum increase in rhizome characters followed by those from Z-0-78. Such variations in rhizome characters of somaclones in ginger depending on parent cultivar have been observed by Paul (2006).

Somaclones recorded significantly higher fresh rhizome yield and dry rhizome yield than parents and check varieties (Table 3, Figs. 1 & 2). All the somaclones derived from Z-0-78 and Z-0-86 and seven somaclones of HP recorded significantly higher fresh rhizome yield over parents while two somaclones of Z-0-78, twelve somaclones of Z-0-86 and three somaclones of HP recorded significantly higher dry rhizome yield over parents. When compared to check varieties, out of the 25 somaclones, 22 and 20 somaclones were significantly superior over check varieties in fresh and dry rhizome yield respectively. The fresh yield of rhizomes ranged between 9.81 and 21.42 t ha^{-1} and dry yield from 1.71 to 3.92 t ha^{-1} in the somaclones. Yield increment in somaclones was more when compared to parent cultivars than check varieties. Variability in rhizome yield in ginger somaclones was reported by Samsudeen (1996), Shylaja *et al*. (2003), Paul (2006), Sumathi (2007) and Kurian (2010).

Somaclones derived from polyploid parent Z-0-86 recorded higher yield of rhizomes compared to somaclones derived from Z-0-78 and Himachal Pradesh. Fresh rhizome yield varied from 11.97 to 21.42 t ha^{-1} in somaclones of Z-0-86, 10.99 to 14.64 t ha^{-1} in somaclones of Z-0-78 and 9.81 to 19.31 t ha^{-1} in somaclones of HP. Somaclone SE 86 81 recorded the highest fresh rhizome yield of 21.42 t ha^{-1} followed by SE 86 142, SE 86 40, SEHP 63, C 86 40 and SE 86 131. Dry rhizome yield varied from 2.13 to 3.92 t ha^{-1} in somaclones of Z-0-86, 2.12 to 3.08 t ha^{-1} in somaclones of Z-0-78 and 1.71 to 3.21 t ha^{-1} in somaclones of HP. Somaclone SE 86 142 recorded the highest dry rhizome yield of 3.92 t ha^{-1} followed by SE 86 81, SE 86 40, C 86 139 and C 86 40. Paul (2006) had reported that the somaclones derived from cultivar Rio-de-Janeiro were high yielding compared to those from cultivar Maran.

In conclusion, somaclones exhibited significant variations compared to parent cultivars and check varieties in various rhizome characters studied. Among rhizome characters, number of quaternary fingers recorded maximum increase followed by internodal length of primary fingers and number of tertiary and secondary fingers. Somaclones showed superiority over parent cultivars in length and inter-nodal length of primary fingers and quaternary fingers while superiority over check varieties was seen for girth of rhizome, number of quaternary, secondary and tertiary fingers. Somaclones derived from polyploid parent Z-0-86 recorded superiority in rhizome characters, driage and dry yield over other somaclones. About 92% of somaclones showed higher fresh rhizome yield over parent cultivars while 84% showed higher rhizome yield over check varieties.

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