Journal of Medicinal and Aromatic Plant Sciences 35(3-4) (2013) 175-178

SHORT COMMUNICATION

Correlation and path analysis of somaclones of ginger (*Zingiber officinale* Rosc.)

RESMI PAUL* • MR SHYLAJA

Article History

Received: 25th March, 2013
Revised: 5th November, 2013
Accepted: 8th November, 2013

Keywords

Correlation
Ginger
Path analysis
Somaclones
Zingiber officinale

ABSTRACT

Correlation and path analysis of rhizome yield-contributing characters were carried out in 82 somaclones of ginger cv. Rio-de-Janeiro regenerated in vitro via adventitious shoot bud organogenesis. The results revealed that the analyzed characters such as height of pseudostem, number of tillers/ plant, number of leaves/ tiller, leaf length, leaf breath, leaf area, number of primary, secondary and tertiary fingers, length and girth of primary and secondary fingers, inter nodal length of primary and secondary fingers, thickness of inner core of rhizome and rhizome yield have positive correlation with crop yield. Direct selection based on leaf area, length and girth of primary fingers, number of tillers/ plant, thickness of inner core of rhizome and number of leaves/ tiller could be taken as good selection criteria to isolated high yielding genotypes of this medicinal herb.

INTRODUCTION

Ginger (*Zingiber officinale* Rosc.), one of the oldest and renowned medicinal plant spices is valued for its aroma, flavour and pungency. It is also a much esteemed medicinal vegetable since ancient times and used as carminative, stimulant, anti-inflammatory and antiemetic in Ayurvedic system of medicine. Due to pre-dominant vegetative mode of propagation and lack of natural seed set, ginger represents a crop with narrow genetic variability base. Broadening the genetic variability through *in vitro* mutagenesis or tissue culture techniques is therefore a viable option for crop improvement programmes in ginger [13, 14]. Earlier crop improvement research on ginger was mainly focusssed on germplasm collection, evaluation and selection of high yielding clones [16]. Induced mutation using gamma rays and ethyl methyl sulfonate (EMS) attempted in ginger gave rise to mutants with very low yield and the effects of mutagen treatment was found to vanish in subsequent generations [5].

Somaclonal variation arise in vitro as a manifestation of heritable or epigenetic changes in the genome of differentiating vegetative cells under tissue culture conditions can serve as powerful tool in genetic improvement of vegetatively propagated crops like ginger [6, 7, 8, 9, 11, 18, 19]. Any genetic change induced by *in vitro* conditions is expected to generate stable variant plants carrying interesting heritable traits. We have earlier reported the field

Department of Plantation Crops and Spices, College of Horticulture, Kerala Agricultural University, Thrissur 680 656, Kerala

* Corresponding author's present address: Department of Pomology and Floriculture, College of Horticulture, Kerala Agricultural University, Thrissur, Kerala 680656; E-mail: resmi_jayee@rediffmail.com

evaluation of a somaclone population of ginger raised through indirect shoot bud organogenesis [13, 14]. In the present study, attempts have been made to carry out a path correlation analysis in this somaclone population to understand the association of rhizome yield with 16 morphological characters to identify traits that can be used in selecting high yielding genotypes.

MATERIALS AND METHODS

Somaclones of ginger cultivar Rio-de-Janeiro, derived through bud culture after passing through 10 to 12 *in vitro* subculture cycles [13, 14], were planted in field for rhizome development to form the base material for the present study. Eighty two somaclones were subsequently evaluated for morphological and yield attributes for three consecutive seasons. The field was ploughed and mounds of size 50 cm height and 30 cm base diameter were prepared at a spacing of 40 cm. Raised beds of size 1 x 1 m were prepared with an interspace of 40 cm between beds. Rhizome bits of 15 to 20 g weight were used as planting material. In first year, single plant evaluation was done in mounds. In second and third year, planting was done in beds or mounds as per the availability of seed rhizomes. The crop was managed as per the standard package of practices at Kerala Agricultural University [10]. Morphological characters like height of pseudostem, number of tillers per plant, number of leaves per tiller, length, width and area of the last fully opened leaf were recorded. Rhizome characters such as number of primary[1^0], secondary[2^0] and tertiary[3^0] fingers, length and girth of primary and secondary fingers, internodal length of primary and secondary fingers, thickness of inner core of rhizome and rhizome yield were recorded for five plants per replication. The aerial morphological characters were recorded at the maximum vegetative growth stage (six months) and rhizome characters at harvest. The pooled data on yield and yield attributes for the different years were subjected to correlation and path analysis as per the design suggested earlier [4].

RESULTS AND DISCUSSION

Correlation analysis of the somaclones as summarized in Table-1 revealed a high positive and significant association of rhizome yield with girth of primary fingers (0.61) followed by thickness of inner core of rhizome (0.52), length of leaf (0.50), leaf area (0.46), number of primary fingers (0.43), number of secondary fingers (0.43), number of tertiary fingers (0.40), length of primary fingers (0.37), girth of secondary fingers (0.35), height of pseudostem (0.34) and number of tillers/ plant (0.34). All the studied characters showed significant positive association with yield except internodal length of primary fingers which were positive but insignificant. Partitioning of the correlation coefficients into direct and indirect effects showed that leaf area followed by length and girth of primary fingers, number of tillers/ plant, thickness of inner core of rhizome, number of leaves/ tiller and number of primary fingers exhibited maximum positive direct effect on rhizome yield (Table 2). Lincy *et al*. [10] have also earlier reported that in somaclones of ginger, girth of primary fingers, number of fingers and length of primary fingers exhibited high positive correlation and maximum positive direct effect on rhizome yield. Ratnambal *et al*. [14] reported that when number of tillers is increased, the yield also increased correspondingly in conventionally propagated plants of ginger. High positive direct effect of tiller number, number of fingers, girth of fingers and plant height with rhizome yield in ginger has also been reported by many workers [1, 4, 12, 17]. Though height of pseudostem, length and breadth of leaf, number and girth of secondary fingers and internodal length of secondary fingers also showed significant positive association with yield, its negative direct effect indicated the inappropriateness of selecting these characters for improving the rhizome yield. All the analyzed characters showed a negative direct effect via height of pseudostem, length and breadth of leaf, number and girth of secondary fingers and internodal length of secondary fingers. But the significant positive correlation of the above mentioned characters with yield may be due to high positive indirect effect of these characters via leaf area, length and girth of primary fingers, number of tillers/ plant, thickness of inner core of rhizome, number of leaves/ tiller and number of primary

Table 1. Correlation matrix for morphological and yield attributes in somaclones of ginger cv. Rio-de-Janeiro

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	Y1
X1	1.00																
X2	0.65**	1.00															
X3	0.84**	0.59**	1.00														
X4	0.61**	0.36**	0.27*	1.00													
X5	0.01	-0.12	-0.09	0.31**	1.00												
X6	0.36**	0.12	0.10	0.78**	0.83**	1.00											
X7	0.15	0.23*	0.21	0.08	0.08	0.10	1.00										
X8	0.34**	0.28*	0.22*	0.31**	0.14	0.27*	0.68**	1.00									
X9	0.38**	0.39**	0.29**	0.31**	0.08	0.22	0.56**	0.89**	1.00								
X10	0.08	0.00	0.01	0.20	0.10	0.17	0.12	0.02	-0.06	1.00							
X11	0.29**	0.19	0.11	0.46**	0.14	0.35**	-0.01	0.26*	0.33**	0.19	1.00						
X12	0.43**	0.23*	0.26*	0.53**	0.23*	0.50**	0.29**	0.45**	0.41**	0.21	0.30**	1.00					
X13	0.35**	0.05	0.16	0.53**	0.26*	0.47**	-0.07	0.26*	0.24*	0.22	0.31**	0.62**	1.00				
X14	0.13	0.21	0.04	0.26*	-0.06	0.09	-0.31	-0.11	-0.05	0.58**	0.29**	0.11	0.19	1.00			
X15	0.25*	0.20	0.17	0.41**	0.08	0.27*	-0.05	0.06	0.16	0.18	0.59**	0.33**	0.21	0.52**	1.00		
X16	0.18	0.04	-0.17	0.38**	0.29**	0.41**	0.23*	0.37**	0.36**	0.18	0.30**	0.52**	0.52**	0.09	0.19	1.00	
Y1	0.34**	0.34**	0.23*	0.50**	0.26*	0.46**	0.43**	0.43**	0.40**	0.37**	0.31**	0.61**	0.35**	0.15	0.23*	0.52**	1.00

*Significant at 0.05 level; **Significant at 0.01 level; Height of pseudostem (X1); No. of tillers/ plant (X2); No. of leaves/ tiller (X3); Length of leaf (X4); Breadth of leaf (X5); Leaf area (X6);No. of 1º fingers (X7); No. of 2º fingers (X8); No. of 3º fingers (X9); Length of 1º fingers (X10); Length of 2º fingers (X11); Girth of 1º fingers (X12); Girth of 2º fingers (X13); Internodal length of 1º fingers (X14); Internodal length of 2º fingers (X15); Thickness of inner core of rhizome (X16); Rhizome yield (Y1)

Table 2. Direct (in bold) and indirect effects of yield components on rhizome yield in somclones of ginger cv. Rio-de-Janeiro

Chara-cter	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	Correlation with yield
X1	**-0.3929**	0.1700	0.1870	-0.0810	-0.0040	0.2794	0.0325	-0.0389	0.0291	0.0246	0.0182	0.1186	-0.0202	-0.0223	-0.0013	0.0421	0.3410**
X2	-0.2540	**0.2629**	0.1329	-0.0471	0.0563	0.0931	0.0495	-0.0326	0.0298	0.0013	0.0123	0.0655	-0.0028	-0.0371	-0.0010	0.0089	0.3380**
X3	-0.3280	0.1560	**0.2240**	-0.0364	0.0411	0.0795	0.0443	-0.0259	0.0219	0.0022	0.0066	0.0724	-0.0092	-0.0079	-0.0008	-0.0039	0.2360*
X4	-0.2399	0.0934	0.0614	**-0.1326**	-0.1493	0.6080	0.0164	-0.0357	0.0233	0.0648	0.0293	0.1475	-0.0304	-0.0467	-0.0021	0.0894	0.4970**
X5	-0.0033	-0.0311	-0.0194	-0.0416	**-0.4754**	0.6543	0.0171	-0.0168	0.0064	0.0328	0.0086	0.0631	-0.0152	0.0106	-0.0004	0.0670	0.2570*
X6	-0.1400	0.0312	0.0227	-0.1028	-0.3967	**0.7842**	0.0203	-0.0308	0.0165	0.0549	0.0222	0.1280	-0.0271	-0.0168	-0.0014	0.0971	0.4620**
X7	-0.0597	0.0609	0.0465	-0.0102	-0.0381	0.0745	**0.2135**	-0.0788	0.0424	0.0373	-0.0004	0.0821	0.0038	0.0055	0.0003	0.0550	0.4340**
X8	-0.1324	0.0742	0.0503	-0.0410	-0.0691	0.2092	0.1459	**-0.1154**	0.0678	0.0050	0.0166	0.1246	-0.0150	0.0193	-0.0003	0.0858	0.4250**
X9	-0.1501	0.1301	0.0645	-0.0407	-0.0401	0.1698	0.1190	-0.1029	**0.0760**	-0.0186	0.0208	0.1147	-0.0136	0.0095	-0.0008	0.0847	0.3950**
X10	-0.0301	0.0011	0.0016	-0.0268	-0.0487	0.1346	0.0249	-0.0018	-0.0044	**0.3201**	0.0120	0.0592	-0.0125	-0.1026	-0.0009	0.0422	0.3680**
X11	-0.1129	0.0511	0.0234	-0.0613	-0.0645	0.2741	-0.0013	-0.0301	0.0250	0.0608	**0.0634**	0.0832	-0.0179	-0.0516	-0.0030	0.0702	0.3090**
X12	-0.1668	0.0617	0.0581	-0.0700	-0.1075	0.3596	0.0628	-0.0515	0.0312	0.0678	0.0189	**0.2792**	-0.0360	-0.0189	-0.0017	0.1214	0.6080**
X13	-0.1376	0.0129	0.0357	-0.0697	-0.1253	0.3684	-0.0139	-0.0300	0.0180	0.0691	0.0197	0.1740	**-0.0578**	-0.0331	-0.0011	0.1226	0.3520**
X14	-0.0492	0.0548	0.0099	-0.0348	0.0284	0.0741	-0.0066	0.0125	-0.0041	0.1846	0.0184	0.0297	-0.0107	**-0.1778**	-0.0026	0.0211	0.1480
X15	-0.0998	0.0520	0.0377	-0.0542	-0.0362	0.2114	-0.0111	-0.0072	0.0124	0.0563	0.0376	0.0929	-0.0122	-0.0930	**-0.0050**	0.0455	0.2270*
X15	-0.0704	0.0100	-0.0038	-0.0505	-0.1355	0.3242	0.0500	-0.0421	0.0274	0.0575	0.0189	0.1443	-0.0301	-0.0160	-0.0010	**0.2349**	0.5180**

R = 0.3633; Height of psendostem (XI);.....Thickness of inner core of rhizome (X16) from earlier table

fingers. Based on our study, the important yield contributing characters that can be useful for selecting high yielding population were turned out be leaf area, length and girth of primary fingers, number of tillers/ plant, thickness of inner core of rhizome, number of leaves/ tiller and number of primary fingers.

REFERENCES

1. Abraham Z, Latha M. 2003. Correlation and path analysis in ginger (*Zingiber ofûcinale* Rosc.). *J Spices Aromatic Crops* **12**: 187–89.
2. Annonymous. 2002. Package of Practices Recommendations: Crops. Kerala Agricultural University, Thrissur, India, 278 p.
3. Das P, Rai S, Das AB. 1999. Genetic advance, heritability and path analysis in ginger (*Zingiber ofûcinale* Rosc.). *J Plantation Crops* **27**: 27–30.
4. Dewey DR, Lu KH. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron J* **51**: 515–518.
5. Dutta AK, Biswas AK. 1985. EMS induced mitotic consequences in three rhizomatous, spice yielding plants. *Chromosome Inf Serv* **38**: 25-26.
6. Kaeppler SM, Kaeppler HF, Rhee Y. 2000. Epigenetic aspects of somaclonal variation in plants. *Pl Mol Biol* **43:** 179-188.
7. Karp A. 1995. Somaclonal variation as a tool for crop improvement. Euphytica **85:** 295-302.
8. Larkin PJ, Scowroft WR. 1981. Somaclonal variation a novel source of variability from cell culture for plant improvement. *Theor Appl Genet* **60**: 197-199.
9. Lee M, Phillips RL. 1988. The chromosomal basis of somaclonal variation. *Ann Rev Pl Physiol Mol Biol* **39:** 413-437.
10. Lincy AK, Jayarajan K, Sasikumar B. 2008. Relationship between vegetative and rhizome characters and final rhizome yield in micropropagated ginger plants (*Zingiber officinale* Rosc.) over two generations. *Sci Hort* **118**: 70-73.
11. Mathur AK, Ahuja PS, Pandey B, Kukreja AK, Mandal S. 1988. Screening and evaluation of somaclonal variations for quantitative and qualitative traits in an aromatic grass, *Cymbopogon winterianus* Jowitt. *Pl Breed* **101:** 321-334.
12. Pandey G, Dhobal VK. 1993. Genetic variability, character association and path analysis for yield components in ginger (*Zingiber officinal* Rosc.). *J Spices Aromatic Crops* **2**: 16–20.
13. Paul R, Shylaja MR. 2012a. Field evaluation of tissue culture-raised somaclones of ginger (*Zingiber officinale* Rose.) for productivity-linked traits. *J Med Arom Pl Sci* **34:** 20-27.
14. Paul R, Shylaja MR. 2012b. Screening of ginger (*Zingiber officinale* Rose.) somaclones derived through indirect organogenesis against soft rot and bacterial wilt diseases. *J Med Arom Pl Sci* **34:** 28-32.
15. Ratnambal MJ, Balakrishnan R, Nair MK. 1980. Multiple regression analysis in cultivars of *Zingiber officinale* Rosc. **In**: *Proc. Nat. Sem. Ginger and Turmeric*, M.K. Nair, T. Premkumar, P.N. Ravindran, Y.R. Sarma (Eds.), Calicut, India, pp.30–33.
16. Rattan RS. 1994. Improvement of ginger. **In**: *Advances in Horticulture: Vol. 10 Plantation and Spice Crops, Part II*. K.L. Chadha and P. Rethinam (Eds.). Malhotra Publishing House, New Delhi, pp. 546-62.
17. Sasikumar B, Nirmal Babu K, Abraham J, Ravindran PN. 1992. Variability, correlation and path analysis in ginger germplasm. *Ind J Genet* **52**: 428 - 431.
18. Shirvin RM, Mc Pheeters KD, Norton M. 1994. Sources and frequency of somaclonal variation. *Hort Sci* **29:** 1232-1237.
19. Smulders MJM, Deklerk GJ. 2011. Epigenetics in plant tissue cultures. *Pl Growth Regul* **63:** 137-146.