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GENETIC VARIABILITY FOR YIELD AND QUALITY TRAITS IN GINGER (*ZINGIBER OFFICINALE* ROSCOE)

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ABSTRACT
The genetic variability, heritability, genetic advance and correlation coefficient were estimated for yield and quality traits in twenty five ginger germplasm. Wide genetic variation was observed for all genotypes for yield per plant, plant height and days taken to harvest. Considering genetic parameters, high GCV was found highest for acidity (42.94%) followed by oleoresin content (37.50%), ascorbic acid content (34.78%) and yield per plant (23.81g), respectively. In all cases, phenotypic variances were higher than the genotypic variances. Based on high heritability coefficient (h^2 b.s.) coupled with high genetic advance as % of mean, oleoresin content (0.98, 76.36%), ascorbic acid content (0.97, 70.42), acidity % (0.93, 85.45%), TSS per cent (0.90, 43.71) and yield per plant (0.87, 45.69) were found superior traits and representing additive genetic variance. Effective selection would be made considering these traits. Genotypic correlation coefficient revealed that rhizome yield had significant positive correlation with length of primary finger (0.40), ascorbic acid content (0.37), number of primary fingers (0.35), plant height (0.36) and diameter of primary finger (0.31).

INTRODUCTION

Ginger (*Zingiber officinale* Roscoe) is an important delicacy, medicine, spice and monocotyledonous perennial herb belonging to the family Zingiberaceae. It is a valuable cash crop and widely used due to its pleasant pungent and spicy aroma required in the manufacture of a number of by products. Ginger plays an important role in Indian Ayurvedic medicine as a folk remedy to promote cleaning of the body through perspiration and stimulate cold treatments whereas ginger oil obtained from dry ginger powder is primarily used as a flavouring agent in confectionary, preservation as well as medicine.

It is basic need to develop high yielding varieties with better quality to increase the production and productivity of ginger in India. The available germplasm serves as most valuable natural reservoir for providing donor parent to improve the particular traits by genetic reconstruction of plant (Hawkes, 1981). Therefore, collection, conservation and evaluation of germplasm are essential for present as well as future crop improvement programmes.

It is urgent need to exploit the existing ginger germplasm for assessing genetic variability, heritability and correlation. Rhizome yield is a complex trait depends upon a number of yield component and their association. Magnitude and direction of association between two or more component result correlation coefficient. Correlation coefficient analysis reveals better understanding of yield component and assists in effective selection and hybridization programmes as similar reported by Johnson *et al*. (1955) and Singh *et al*. (1985). Keeping this in background, the present paper deals with the genetic variability for yield and quality traits in ginger.

MATERIALS AND METHODS

The present experiment was conducted under net house at main experiment station of Department of Vegetable Science, Narendra Dev University of Agriculture and Technology, Kumarganj, Faizabad (U.P.), India during kharif season, 2007-08 and 2008-09 to characterize twenty five ginger accessions collected from different locations of India in Randomized Block Design (RBD) with three replications (Table 1). The experimental site is located in between 24.47° and 26.56° N latitude and 82.12° and 83.98° E longitude having elevation of 113 m above the mean sea level in the Gangetic alluvial plains of eastern Uttar Pradesh which falls under humid sub-tropical climate. The experimental field had sandy loam, slightly alkaline soil (pH 8.0), low in organic carbon and nitrogen, medium in phosphorus and potassium. The experimental field was prepared by harrowing with hand hoeing followed by leveling whereas well decomposed manure F.Y.M @ 15 tonnes

per hectare were applied at 30 days before sowing. Selected rhizomes of large shiny, free from spots or marks bud or eye injury were cut into pieces of 3-5cm in the length, 15- 20gm in weight and at least one sound bud treated with fungicide like carbendazim or mancozeb by dissolving 30 gm of the chemicals in 15 litres water as a safeguard against soft rot and to induce early sprouting as similar reported by Ravishanker *et al*., 2013. Single row of 1.40 m plot with the spacing of 40 cm row to row and 20cm plant to plant was maintained. The each germplasm pieces were sown on 18th may in 2007 and irrigation was done at weekly interval during summer as per requirement. Recommended package and protective measures were followed to raise healthy crops. The data were recorded from five randomly selected plants from each treatment in each replication and replication wise mean data was used for statistical analysis for thirteen diverse traits *viz*. plant height (cm), girth of plant (cm), days taken to harvest, number of primary fingers, length of primary fingers (cm), diameter of primary fingers (cm), numbers of secondary fingers, TSS (%), acidity (%), ascorbic acid content (mg/100g of edible portion), dry rhizome recovery (%), oleoresin content (%) and fresh yield per plant (g).

The analysis of variance (ANOVA) for RBD was estimated according to Panse and Sukhtame (1989) (Table 2). The genotypic and phenotypic variances were calculated according to Johnson *et al*. (1955) and Comstock and Robinson (1952). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated by the method suggested by Singh and Chaudhary (1985) whereas heritability in broad sense for yield and its components were worked out by using formula suggested by Hanson *et al*. (1956). Genetic advance (GA) was calculated by the method suggested by Johnson *et al*. (1955). Genotypic and phenotypic correlations were partitioned using the technique outlined by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Extreme significant treatment variance was found for all 13 diverse traits (Table 2). High GCV was found for acidity, oleoresin content, ascorbic acid, yield per plant and T.S.S. (Table 2). Based on genetic variability analysis, only six genotypes out of twenty five genotypes viz. Sultanpur-2, FZD-2, NDG-41, NDG-8, NDG-22 and NDG-18 were found to be most promising for rhizome yield and quality traits. In general, PCV estimates were higher than GCV estimates for all studied traits (Table 3). The GCV was found highest for acidity (%) (42.94) followed by oleoresin content (37.50), ascorbic acid content (34.78) and yield per plant (23.81), respectively. It indicates that the presence of maximum amount of genetic variability which emphasized the wide scope of selection for the improvement of these characters (Ravishanker *et al*., 2013). The influence of environment was expected to be minimum when difference between GCV and PCV was less in magnitude

Table 1: Collection of 25 indigenous ginger genotypes from selected areas of India

S. No.	Accessions	Area of collection
1.	DEO-1, DEO-2, DEO-3	Deoria district, U.P.
2.	FZD-1, FZD-2, NDG-6, NDG-8, NDG-12, NDG-14, NDG-16, NDG-18, NDG-22, NDG-35, NDG-36, NDG-39, NDG-41, NDG-53	Faizabad district, U.P.
3.	Suprabha, V2E5-2, PGS-8	Calicut district, Kerala
4.	JNP-1, JNP-2, JNP-3	Jaunpur district, U.P.
5.	Sultanpur-1, Sultanpur-2	Sultanpur district, U.P.

Table 2: ANOVA for yield and quality contributing 13 diverse traits in ginger

Source	d.f.	Plant height (cm)	Girth of plant (cm)	Days takento harvest	No. of primary finger	Length of primary finger	Diameter of primary finger	No. of secondary finger	TSS (%)	Acidity (%)	Ascorbic acid content (mg/100g)	Dry matter content (%)	Oleoresin content (%)	Yield/ plant (fresh) (g)
Replications	2	391.03	0.00	898.62	0.14	0.06	0.03	0.15	0.07	0.00	0.21	0.14	1.37	1232.56
Treatments	24	276.01**	0.04*	354.19**	1.60*	0.48*	0.18*	1.81*	11.44*	0.14*	7.68*	13.70**	12.75**	4505.67**
Error	48	63.31	0.00	278.09	0.07	0.05	0.01	0.10	0.40	0.003	0.08	1.50	0.09	218.02

Table 3: Mean, genotypic and phenotypic coefficient of variability, heritability (broad sense) and genetic advance of yield and quality contributing traits in ginger

Traits	Grand mean (X) ± SE	Genotypic variance Vg	Phenotypic variance Vp	Coefficient of variability ECV	GCV	PCV	Heritability (broad sense)	Genetic advance	Genetic advance as % of mean
Plant height (cm)	92.97±4.59	70.90	134.21	8.56	9.06	12.46	0.53	12.61	13.56
Girth of plant (cm)	0.96±0.47	0.01	0.02	8.37	11.84	14.50	0.67	0.19	19.91
Days taken to harvest	257.28± 9.63	25.37	303.46	6.48	1.96	6.78	0.08	3.00	1.17
No. of primary finger	3.91 ± 0.16	0.51	0.58	6.92	18.29	19.56	0.88	1.38	35.25
Length of primary finger	3.83 ± 0.14	0.14	0.20	6.39	9.89	11.78	0.71	0.66	17.11
Diameter of primary finger	2.16 ± 0.06	0.06	0.07	4.73	11.27	12.22	0.85	0.46	21.41
No. of secondary finger	4.55 ± 0.18	0.57	0.67	7.03	16.62	18.04	0.85	1.43	31.52
TSS (%)	8.59 ± 0.37	3.68	4.08	7.38	23.35	23.53	0.90	3.75	43.71
Acidity (%)	0.50 ± 0.03	0.05	0.05	11.55	42.94	44.46	0.93	0.43	85.41
Ascorbic acid content (mg/100g)	4.58 ± 0.71	2.53	2.62	6.51	34.78	35.38	0.97	3.23	70.42
Dry matter content (%)	17.75 ± 0.71	4.07	5.57	6.91	11.36	13.30	0.73	3.55	20.00
Oleoresin content (%)	5.48 ± 0.18	4.22	4.32	5.72	37.50	37.93	0.98	4.18	76.36
Yield per plant (fresh) (g)	158.78 ± 8.53	1429.22	1647.25	9.30	23.81	25.57	0.87	72.54	45.69

Table 4: Genotypic and phenotypic correlation coefficient between yield and quality contributing traits in ginger

Traits		Girth of plant (cm)	Days taken to harvest	No. of primary finger	Length of primary finger	Diameter of primary finger	No. of secondary finger	TSS (%)	Acidity (%)	Ascorbic acid content (mg/100g)	Dry matter content (%)	Oleoresin content (%)	Yield per plant (fresh) (g)
Plant height (cm)	r_p	0.15	-0.06	0.35**	0.19	0.17	0.06	0.30*	-0.04	0.17	-0.07	0.19	0.23*
	r_g	0.26*	0.11	0.49**	0.19	0.13	0.17	0.40**	-0.06	0.20	-0.25*	0.27*	0.36*
Girth of plant (cm)	r_p		0.02	0.05	0.28*	0.25	-0.11	0.07	-0.16	-0.26*	0.10	-0.18	-0.10
	r_g		0.31*	0.02	0.35**	0.38	-0.03	0.04	-0.24	-0.31*	0.12	-0.22	-0.04
Days taken to harvest	r_p			-0.24*	0.06	0.12	0.00	0.08	0.10	-0.24*	-0.10	0.08	0.09
	r_g			-0.55**	0.25*	0.31*	0.04	0.30*	0.49**	-0.72**	-0.38**	0.09	-0.11
No. of primary finger	r_p				0.22*	-0.07	0.31*	0.11	-0.27*	0.08	0.26	-0.01	0.27*
	r_g				0.32*	-0.06	0.40**	0.14	-0.26*	0.08	0.33	0.01	0.35**
Length of primary finger	r_p					0.09	0.00	-0.13	0.14	0.02	-0.01	-0.16	0.27*
	r_g					0.11	-0.01	-0.19	0.13	0.02	-0.04	-0.21	0.40**
Diameter of primary Finger finger	r_p						0.05	0.03	0.24*	0.18	-0.14	-0.18	0.28*
	r_g						0.06	0.02	0.25*	0.18	-0.14	-0.21	0.31*
No. of secondary finger	r_p							0.29*	-0.13	-0.09	0.19	0.25*	0.03
	r_g							0.32*	-0.15	-0.07	0.32**	0.27*	0.01
TSS (%)	r_p								-0.03	0.10	0.32**	0.26*	-0.08
	r_g								-0.04	0.12	0.40**	0.28*	-0.05
Acidity (%)	r_p									0.39**	-0.19	-0.31*	0.05
	r_g									0.42**	-0.24*	-0.32*	0.07
Ascorbic acid content (mg/100g)	r_p										0.02	-0.06	0.32*
	r_g										0.02	-0.07	0.37**
Dry matter content (%)	r_p											0.07	0.17
	r_g											0.09	0.21
Oleoresin content (%)	r_p												-0.08
	r_g												-0.09

for all studied characters as similar reported by Pandey and Dobhal (1993); Tiwari (2003) and Singh and Mittal (2003). Genotypic variance were highest for yield per plant (fresh) (1429.22) followed by plant height (70.90) and days taken to harvest (25.37), respectively (Table 3). High heritability with low genetic advance in per cent of mean was observed for no. of secondary branches, diameter of primary finger and girth of plant which indicated the involvement of non-additive gene action for the expression of these traits and selection for such trait might not be rewarding. Based on high heritability coefficient (h^2 bs) along with high genetic advance as percent of mean, oleoresin content (0.98, 76.36%), ascorbic acid content (0.97, 70.42), acidity % (0.93, 85.45%), TSS per cent (0.90, 43.71) and yield per plant (0.87, 45.69) were found superior traits and representing additive genetic variance (Table 3) therefore, effective selection can be made for these traits as similar reported by Singh, *et al.,* 2003; Yadav, 1999; Mohanty and Sarma, 1979; Rao *et al*., 2004 and Baranwal *et al.,* 2012. Architecture of ginger rhizome as well as other tuber crops is basic selection parameter based on overall net effect produced by various yield components directly or indirectly by interacting with each another. Genotypic correlation coefficient revealed that rhizome yield had significant positive correlation with length of primary finger (0.40), ascorbic acid content (0.37), plant height (0.36), no. of primary fingers (0.35) and diameter of primary finger (0.31). Among component traits, positive and significant association was observed between plant height with no. of primary finger (0.49) and total soluble solid (TSS) (0.40); length of primary finger with girth of plant (0.35) and no. of primary finger (0.32); TSS with no. of secondary finger (0.32) and dry matter content (0.40); acidity with diameter of primary finger (0.25), days taken to harvest (0.49) and ascorbic acid content(0.42); no. of secondary finger with oleoresin content (0.27) as similar reported by Mohanty and Sharma (1979); Mukhopadhyay and Roy (1986); Yadav and Singh (1987); Chandra and Govind (1999); Singh (2001) and Abraham and Latha(2003). Among component traits, negative and significant association was observed between acidity with number of primary finger (-0.26) and oleoresin content (-0.32); ascorbic acid content with girth of plant (-0.31)and days taken to harvest(-0.72) ; dry matter content with days taken to harvest (-0.38) (Table 4).

Continuous selection for yield and quality traits is known for fixing of genetic variability in crop plants (Desclaux, 2005). The present study indicated a broad genetic base in the ginger germplasm of India. This finding is in agreement with the findings of Jatoi *et al.,* (2006) who observed high degree of genetic variation in Asian collection of ginger.

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