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Genetic analysis of variability, heritability and genetic advance as percent of mean in different cut flower type of red ginger (*Alpinia purpurata* (Vieill.) K. Schum) collections under shadenet condition

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Abstract
To identify elite collections to be employed in breeding programs, studies on genetic variability, heritability, and genetic advance as percent of mean were conducted among thirteen collections of red ginger. The results showed maximum phenotypic and genotypic co-efficient of variation for characteristics like yield per plant (GCV = 64.03%; PCV =65.05%) followed by length of inflorescence (GCV = 61.93%; PCV = 67.54%). The highest possible heritability values were attained in yield per plant (96.89%) followed by length of inflorescence (91.09%). High genetic advance as a percentage of the mean and a high heritability estimate were found for yield per plant (78.97%) followed by length of inflorescence (76.08%). High heritable variability was found for characters like days taken for flower bud initiation, length of inflorescence, girth of spike at the base, number of bracts per spike, fresh weight of stem, vase life and spike yield which can be used in future crop breeding programmes.

Keywords: Red ginger, PCV, GCV, heritability, GAM

Introduction
In the Zingiberaceae family, Alpinia is the largest genus. *Alpinia purpurata* (Vieill.) K. Schum (2n=48), often known as red ginger, is a tall, perennial, evergreen, rhizomatous, scented, and herbaceous plant with a height of 30 to 250 cm. Rhizomes form clusters and extend laterally when aerial shoots appear. Within two to three years, the leafy branch forms massive clusters and ends in an inflorescence. The 20–40 cm long inflorescence is made up of spectacular, vividly coloured bracts that are grouped spirally. The true bloom is hardly perceptible, white, tubular and smaller than the bract (Baskaran *et al.*, 2021) [5]. Because of its gorgeous flower bracts, which come in a variety of colours, lush green foliage, year-round flowering and exceptional post-harvest properties, red ginger is frequently used in landscaping and as cut flower. It is also suitable as an intercrop in coconut gardens under partial shade and is suitable as an intercrop in coconut gardens. Some of the important varities are jungle king, raspberry, red dwarf and gingosa which are red in colour and jungle queen, eileen mcdonald, fireball, hot pink, pink cone, rosy dawn, darwin series, dwarf pink, kimi and polynesian princess are pink coloured.

White cone ginger and anne hironaka have white bracts. tomie pink has light pink bracts with white stripes on periphery of bracts. Tahitian red ginger is double variety. CIARI red ginger-1 is a unique collection with multiple spikes released from Central Island Agricultural Research Institute (CIARI), Port Blair (Baskaran *et al.*, 2021) [5].

It is vital to identify cultivars that can be grown for certain applications under different agro-climatic conditions. The kind and level of variability present in the current material, as well as the correlations between the various traits, must be understood by any breeding program aiming to produce high yield and high quality offspring. The estimation of the phenotypic and genotypic co-efficients of variability of various polygenic characteristics is made possible by variance analysis. The amount of variance in various qualities brought on by a genotype's innate ability is measured by the genotypic co-efficient of variation. Understanding how environment affects distinct polygenic traits requires knowledge of the genotypic and phenotypic co-efficients of variation (Allard, 1960) [3]. Heritability, a predictor in plant breeding, is a measure of the phenotypic variance attributable to genetic causes. It displays the propensity of a specific morphogenetic characteristic to be transmitted to succeeding

generations. Heritability, a predictor in plant breeding, is a measure of the phenotypic variance attributable to genetic causes. It displays the propensity of a specific morphogenetic characteristic to be transmitted to succeeding generations. The goal of the current study was to select elite collections to be used in breeding programs and analyze the kind and degree of variability present in thirteen collections in order to increase crop output.

Table 1: List of different treatments (collections) used in the experiment and their source of collection

Treatments	Collections	Source of collection	GPS Co-ordinates
T_1	MUD-1	College of Horticulture, Mudigere	13.115232^{0}N, 75.630830^{0}E
T_2	MUD-2	College of Horticulture, Mudigere	13.115232^{0}N, 75.630830^{0}E
T_3	UCL-1	East-West Nursery, Uchila	13.191019^{0}N, 74.770713^{0}E
T_4	KAP-1	S. M. Nursery, Kaup	13.207341^{0}N, 74.751991^{0}E
T_5	COHB-1	College of Horticulture, Bangalore	13.089809^{0}N, 77.560297^{0}E
T_6	UASB-1	University of Agricultural Sciences, Bangalore	13.081449^{0}N, 77.576935^{0}E
T_7	MUD-3	Farmer's field, Mudigere	13.249178^{0}N, 75.656781^{0}E
T_8	COHB-2	College of Horticulture, Bangalore	13.089809^{0}N, 77.560297^{0}E
T_9	LBG-1	Lalbagh Botanical Garden, Bangalore	12.951065^{0}N, 77.584852^{0}E
T_{10}	KNB-1	HRS, Kanburgi, Belagavi	15.903007^{0}N, 74.564697^{0}E
T_{11}	KGH-1	Kaveri Guesthouse, GKVK, Bangalore	13.030885^{0}N, 77.588152^{0}E
T_{12}	EMP-1	Emphasis nursery, Bangalore	13.201193^{0}N, 77.521946^{0}E
T_{13}	cv. Jungle King	University of Agricultural Sciences, Dharwad	15.489081^{0}N, 74.981466^{0}E

Materials and Methods

The present study was conducted at the Regional Horticultural Research and Extension Centre, College of Horticulture, University of Horticultural Sciences campus, Gandhi Krishi Vignana Kendra, Bengaluru during 2021-22. The center is at an altitude of 930 meters above mean sea level and 12°58' North latitude and 77°35' East longitude. The maximum mean temperature during the research period varied from 25.72 °C to 35.47 °C. While, the minimum mean temperature ranged from 16.66 °C to 23.05 °C. The pH of the soil ranged from 6.00 to 7.4. The soil was red sandy loam with nearly consistent fertility. The experimental material comprised of thirteen collections of red ginger collected from different pockets of Karnataka (Table 1) with spacing of 75 cm X 75 cm. During the years 2021–2022, the experiment was carried out using a Randomized Complete Block Design (RCBD) with three replications. For the purpose of collecting data on seventeen vegetative, floral, and yield-related variables, five plants per replication were chosen. The successful crop was raised using consistent cultural approaches. Utilizing Indostat, the recorded data was examined. According to Burton and De Vane (1953) [1], estimates were made for genetic factors including genotypic and phenotypic coefficients of variation and heritability. Low (less than 10%), moderate (10% to 20%), and high (greater than 20%) were used to categorize the genotypic and phenotypic coefficient of variation. Heritability in the broad sense (h2) was divided into three categories: low (0 to 30%), moderate (31% to 60%), and high (61% and above). According to Johnson et al. (1955) [2], the genetic advance was calculated as a percentage mean and was divided into three categories: low (less than 10%), moderate (10% to 20%), and high (more than 20%).

Results and Discussion

Data on phenotypic and genotypic co-efficient of variations, heritability and genetic advance for different traits are presented in Table 2. The GCV ranged from 6.03 % (leaf area) to 64.03 % (yield per plant) and PCV ranged from 14.52 (leaf width) to 65.05 (yield per plant). High PCV and GCV was observed for eleven traits out of which yield per plant (GCV = 64.03%; PCV =65.05%), length of inflorescence (GCV = 61.93%; PCV = 67.54%), size of inflorescence (GCV = 39.51%; PCV = 40.36%) and number of bracts per spike (GCV = 28.26%; PCV = 28.90%) are crucial characteristics that plant breeders can be impressed by in order to effectively use the present variability for future breeding programs. High differences in GCV and PCV were found for plant height, plant spread (east-west), plant spread (north-south), leaf length, leaf width, leaf area, number of leaves per shoot and number of shoots. The lower PCV and GCV values show that these traits make people very vulnerable to unforeseen environmental impacts. The genotypic coefficients of variation were found to vary with the characters, indicating the existence of genetic variety for the various qualities. Minimum genotypic and phenotypic coefficient of variation were noticed for the character inflorescence diameter (GCV = 8.99%; PCV = 11.92%). Narrow difference in phenotypic and genotypic co-efficient of variation were obtained for length of flower stalk, size of the inflorescence, girth of the spike at the base, number of bracts per spike and fresh weight of the stem, indicating least environmental effects on these characters. Similar results were recorded by Basavarajappa *et al.* (2018) [4] in bird of paradise. Thus, these traits expressed the true genetic potential in varied environments and can be utilized for breeding programmes.

Heritability estimates varied from 12.18 (length of flower stalk) to 96.89 (yield/plant) per cent. Highest heritability values were noticed for yield per plant (96.89%), length of inflorescence (91.09%), fresh weight of stem (86.65%), girth of spike at the base (86.32%), size of the inflorescence (85.84%), number of bracts per spike (85.65%), plant height (75.77%) and leaf length (65.83%). Similar results were obtained by Malakar and Biswas (2019) [6] in heliconia for number inflorescence per plant and for number of bracts per inflorescence.

Estimates of heritability combined with genetic progress serve as an effective selection criterion. GAM estimates varied from 3.92 (length of flower stalk) to 78.97 (yield/plant) per cent. High heritability estimate coupled with high genetic advance as per cent of mean was observed for yield per plant (78.97%), length of inflorescence (76.08%), fresh weight of stem (64.27%), girth of spike at the base (61.63%), number of bracts per spike (53.96%), plant height (53.40%), leaf length (44.14%), inflorescence diameter (38.69%), vase life (34.70%), number of leaves per shoot (29.60%), plant spread (East-West direction) (28.45%) and number of shoots

(21.31%) showing the function of additive gene action in the production of certain traits, and as such, might be regarded as trustworthy selection indices. The result is in conformity with the findings of Malakar and Biswas (2019) [6] in heliconia for yield and flower quality parameters.

Table 2: Estimates of genetic parameters in red ginger collections

Sl. No.	Traits	Range		Grand mean	PCV (%)	GCV (%)	Heritability (%)	GAM (%)
		Minimum	Maximum					
1	Plant height (cm)	42.87	65.73	50.68	36.62	30.81	70.77	53.40
2	Plant spread (E-W direction)	51.65	82.22	66.82	26.17	19.01	52.78	28.45
3	Plant spread (N-S direction)	52.70	78.15	68.82	19.34	10.06	53.01	15.57
4	Leaf length (cm)	15.74	24.79	19.51	32.55	26.41	65.83	44.14
5	Leaf width (cm)	6.60	9.48	7.78	14.52	7.67	27.87	8.34
6	Leaf area (cm^2)	88.50	117.04	104.61	16.58	6.03	13.23	4.50
7	Number of leaves per shoot	7.10	11.98	9.10	25.52	19.15	56.32	29.60
8	Number of suckers	26.04	45.93	34.07	23.05	15.44	44.87	21.31
9	Days taken for flower bud initiation (days)	154.26	216.73	182.82	21.22	13.08	38.00	16.61
10	Length of flower stalk (cm)	31.01	60.67	45.33	15.63	15.45	12.18	3.92
11	Length of inflorescence (cm)	10.20	13.97	11.79	67.54	61.93	91.09	76.08
12	Inflorescence diameter(cm)	2.03	2.98	2.57	11.82	8.99	57.94	38.69
13	Size of inflorescence(cm^2)	26.80	18.40	21.94	40.36	39.51	85.84	57.36
14	Girth of spike at the base (cm)	0.31	0.68	0.53	27.34	26.83	86.32	61.63
15	Number of bracts per spike	24.41	35.09	30.53	28.90	28.26	85.65	53.96
16	Fresh weight of stem (g)	8.30	6.14	6.94	23.91	23.42	86.65	64.27
17	Vase life (days)	6.10	8.31	6.94	49.70	33.19	44.60	34.70
18	Yield per hectare (spikes/plant)	3.19	8.53	4.82	65.05	64.03	96.89	78.97

PCV – Phenotypic Co-efficient of Variation GCV – Genotypic Co-efficient of Variation GAM – Genetic Advance as percent of Mean

Conclusion

According to the current study, variables including yield per plant, inflorescence length, inflorescence size, and number of bracts per spike show heritable variability in the breeding materials that can be employed for future breeding programs.

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