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Extent of Variability, Correlation and Path Studies among Different Ginger Genotypes Grown under Shade Net

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A B S T R A C T

The experiment was taken up to elicit the information on performance of different ginger (*Zingiber officinale* Rosc.) varieties under shade net condition. The trial was conducted in the shade net of the Department of Horticulture, college of Agriculture, Raichur, Karnataka. Eleven varieties of ginger were evaluated in RBD with three replications during *kharif* season of 2018-19. Karnataka. The growth performance of eleven varieties indicated significant variation at all the stages of crop growth under shade net condition. Highest h^2 was associated with the characters like weight of secondary rhizomes (90.58), yield per hectare (89.06), leaf area (87.64), number of leaves per plant (85.40), number of tillers per plant (76.64), weight of primary rhizomes (74.81) and oleoresin content (71.09). The correlation studies carried out by considering various growth and yield parameters established the highly significant and positive correlation of rhizome yield with plant height, number of leaves, number of tillers, plant girth, leaf area, number of primary rhizomes, number of secondary rhizomes, weight of primary rhizomes, weight of secondary rhizomes and Oleoresin content. The characters leaf area, weight of primary rhizomes, number of tillers, weight of secondary rhizomes, plant height, plant girth oleoresin and dry rhizome recovery had their direct positive influence on the rhizome yield. However, number of leaves, number of primary rhizomes and number of secondary rhizomes had their direct negative influence on the rhizome yield.

Introduction

Ginger is one of the most important and ancient spice crops in India, belongs to the family *Zingiberaceae* under the natural order *Scitamineae*. It is a tropical plant, believed to have originated in South East Asia probably India or China (Bailey, 1949). Ginger is an herbaceous perennial and rhizomatous spice crop containing volatile oil, fixed oil, pungent compounds, resins, starch, protein and minerals. Among the several components, 'alpha zingiberene' is the predominating component of essential oil. 'Gingerol' and 'Shagoal' are responsible for the characteristic pungency of the ginger rhizome.

The refreshing aroma and the pungent taste make ginger an essential ingredient of food. Ginger powder is also an essential ingredient in varieties of masala or spice mixes. Ginger is used in several food articles viz., bread, biscuit,

cake, pudding, soup and pickle. According to the Indian system of medicine i.e., Ayurveda, ginger rhizome is carminative and digestive. It is believed to be useful in treating dropsy, asthma, cough, diarrhoea, flatulence, nausea and vomiting.

Variability estimates of different growth and yield characters in eleven varieties have been studied emphasising on range and mean value of each character followed by genetic coefficient of variance, phenotypic coefficient of variance, genetic advancement, genetic advancement as per cent mean and broad sense heritability.

Based on these variability estimates the significance of the characters under consideration was assessed for its effect in improving the selection process of the promising genotypes with the significant characters under the study.

Materials and Methods

Eleven varieties of ginger *viz*., Rio-de-Janerio, IISR Mahima, Mahim 1, Mahim 2, Himachal, IISR Varada, Basavakalyan -1, Humnabad Local, Maran, Sirsi Local, IISR Rajetha were taken up for the study. The experimental site was located at Main Agriculture Research Station, Division of Horticulture, College of Agriculture, University of Agricultural Sciences, Raichur.

The experiment was laid out in a Randomized Block Design with 3 replications in plot size of 7.5×1 m^2. Ginger rhizomes were planted on the beds at a spacing of 45 cm×30 cm. Before planting the rhizomes, they were dipped in solution containing, Streptocyclin (0.01%), Bavistin (2 g lit^{-1}) and Chloropyriphos (2 ml lit^{-1} of water). The soil was red sandy loam with good drainage and moderate water holding capacity. Before planting the experimental field was brought to a fine tilth and planting was done during the last week of May. Fertilizers were applied as per recommendations in package (Anon., 2014).

Statistical analysis

The mean data were subjected to statistical analysis for estimating genetic parameters. Correlation coefficients at genotypic and phenotypic level were estimated by using formula suggested by Al-Jibouri *et al.,* (1958) and path coefficient analysis was done using formula given by Dewey and Lu (1959).

Results and Discussion

Variability studies in different ginger genotypes

Twelve different characters comprising of growth, yield and quality parameters were assessed for variability studies to know their influence on environment, extent of variability existing for selection of the character, the GA and their mean coupled with heritability to know the additive or non additive actions of genes for inheritance of the particular character (Table 1).

Range and mean

Plant height had a range of 61.48 cm to 85.08 cm with its mean value of 70.91 cm. The range of the plant height was narrow. Number of leaves per plant ranged between 99.83 to 282.67 with a mean of 151.34. This parameter was under wide range indicating wide variability of the character. Number of tillers per plant had a range of 11.45 to 22.45 with mean of 15.45. The range of this parameter was narrow. Plant girth ranged between 3.40 cm to 4.00 cm with a mean value of 3.46 cm. Majority of the genotypes exhibited thinner stems. Leaf area ranged between 9810.52 cm^2 to 14186.86 cm^2 with mean value of 6506.87 cm^2. Number of primary rhizomes ranged between 6.23 to 7.9 with a mean value of 6.82. The range is very narrow. Number of secondary rhizomes ranged between 16.43 to 22.70 with a mean value of 20.06. Weight of primary rhizomes ranged between 79.78 g to 118.71 g. The mean was found to be 109.45 g. Weight of secondary rhizomes ranged between 32.81 g to 107.49 g with an average value of 61.65 g. Oleoresin content ranged between 4.38 to 9.33 per cent with an average value of 5.98 per cent. Dry rhizome recovery ranged between 18.55 to 26.47 per cent with a mean value of 22.07 per cent. The range of yield per hectare was found to be between 1.77 to 13.54 tonnes with a mean value of 6.07 tonnes.

Genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV)

Genotypic coefficient of variance (GCV)

The highest per cent of GCV was associated with the character leaf area (49.77) followed by number of leaves per plant (36.4143), weight of secondary rhizomes (34.88), weight of primary rhizomes (25.79), oleoresin content (25.02). Apart from these parameters yield per

hectare had the highest per cent of GCV which was 51.92. The above parameters which expressed more than 20 per cent GCV might be categorised as characters with high GCV. Plant height (7.55), plant girth (7.35), number of secondary rhizomes (6.20) and dry rhizome recovery (9.96) expressed less than 10 per cent GCV which were categorised as characters with low GCV. Only the number of tillers per plant (19.47) was categorised as moderate.

Phenotypic coefficient of variance (PCV)

The characters which exhibited more than 20 per cent of PCV were considered as the characters with high PCV. Yield per hectare (55.01), leaf area (53.16), number of leaves per plant (39.40) and weight of secondary rhizomes (36.67). Oleoresin content (29.68) and number of tillers per plant (22.24) were the characters with high per cent of PCV. None of the characters under study were categorised with low PCV (less than 10 %). Plant height (14.24), plant girth (10.19), number of primary rhizomes (13.42), number of secondary rhizomes (12.55) and dry rhizome recovery with 13.55, exhibited PCV between 10 to 20 per cent and were categorised as moderate characters.

The characters such as plant height, number of primary rhizomes and number of secondary rhizomes. Expressed wide difference between GCV and PCV. This implies that the characters were under the influence of environment. The selection process based on these characters might not be effective in improving the crop. Rest of the characters such as number of leaves, number of tillers, plant girth, leaf area, weight of primary rhizomes and weight of secondary rhizomes exhibited narrow difference between PCV and GCV. This implies that these characters were not influenced by the environment. The selection procedure based on the consideration of these characters would result in effective crop improvement. Similar observations were made by Ravishanker *et al.,* (2013).

Genetic advancement as per cent mean (GAM)

The characters with more than 21 per cent GAM were categorised as high GAM. Yield per hectare (100.93), leaf area (95.98), number of leaves per plant (69.32), weight of secondary rhizomes (68.39), weight of primary rhizomes (45.96), oleoresin content (43.47) and number of tillers per plant (35.12) were the characters with high GAM.

The characters with 11 to 20 per cent GAM were considered as moderate GAM. Dry rhizome recovery (15.08) and plant girth (10.93) were the characters which had moderate GAM.

The plant height (8.24), number of secondary rhizomes (6.31) and number of rhizomes (1.61) were the characters which had less than 10 per cent GAM.

Broad sense heritability (h2)

Highest h^2 was associated with the characters like weight of secondary rhizomes (90.58), yield per hectare (89.06), leaf area (87.64), number of leaves per plant (85.40), number of tillers per plant (76.64), weight of primary rhizomes (74.81) and oleoresin content (71.09). All of these characters were considered as high h^2 (more than 60.1 %).

Dry rhizome recovery (54.03) and plant girth (52.08) were considered as moderate h^2 (30.1 to 60 %).

Number of primary rhizomes (5.85), number of secondary rhizomes (24.40) and plant height (28.09) were categorised as low heritable characters.

The characters plant height, number of primary rhizomes and number of secondary rhizomes, expressed low heritability coupled with low genetic advance, which indicates that these characters are of low inheritability. Hence the selection procedures followed in crop improvement considering these characters might not be effective. Similar observations were recorded by Narayanpur (2001).

Correlation studies

The different independent parameters would influence on the dependent parameter. The extent of the influence are the correlation between the dependent and independent parameters and the same is estimated by the correlation studies. In the present study eleven independent parameters have been considered to study their extent of positive or negative correlation on the dependent parameter *i.e*., rhizome yield per clump.

The data on correlation coefficient existing among the different growth and yield parameters which in turn had an influence on the rhizome yield per hectare have been depicted in Table 2.

Plant height

Plant height influenced the yield parameter as depicted by correlation effect. Significant and positive correlation of plant height was established with weight of secondary rhizomes (0.5544) followed by the association of number of tillers (0.5206), weight of primary rhizomes (0.4999), leaf area (0.4495), number of secondary rhizomes (0.4472) and number of leaves (0.4218).

The correlation coefficient of rhizome yield was observed to be 0.6658. However the association of plant height and oleoresin content were found to have least correlation (0.1444) with yield.

Number of leaves

Positive and significant association of number of leaves was noticed with leaf area (0.9850) followed by number of tillers (0.8319), weight of primary rhizomes (0.8119), weight of secondary rhizomes (0.7625), number of secondary rhizomes (0.5209), plant girth (0.4846) and number of primary rhizomes (0.4840).

The correlation coefficient of yield as a result of number of leaves was found to be 0.8428. However number of leaves have least correlation with oleoresin content (0.1966).

Number of tillers

The association of number of tillers was found to have significant effect on rhizome yield. The number of tillers was positively correlated with weight of secondary rhizomes (0.8874), leaf area (0.8620), weight of primary rhizomes (0.7658) number of secondary rhizomes (0.5646), plant girth (0.5276), number of leaves (0.4846) and number of primary rhizomes (0.4801). The association of number of tillers with dry rhizome recovery was found to be significantly least (0.1874).

Plant girth

The plant girth was found to establish significant association with yield through number of leaves (0.9850), number of tillers (0.8620), weight of secondary rhizomes (0.5655), leaf area (0.4982), plant height (0.4495), number of secondary rhizomes (0.3465) and However the association of plant girth with that of number of primary rhizomes (0.2534) was found to have lesser association with yield.

Leaf Area

The leaf area established significant and positive association with yield through weight of primary rhizomes (0.8101), weight of secondary rhizomes (0.8060), number of secondary rhizomes (0.5530), number of primary rhizomes (0.5185), number of leaves (0.4840) and number of tillers (0.4801). However the association of leaf area with that of oleoresin content was found to be the least (0.1975).

Number of primary rhizomes

The positive and significant correlation of number of primary rhizomes was established with number of tillers (0.5646) followed by leaf area (0.5530), number of leaves (0.5209), weight of secondary rhizomes (0.4889), weight of primary rhizomes (0.4766), plant height (0.4472) and plant girth (0.3465). The correlation coefficient of rhizome yield was observed to be 0.5324. The association of number of primary rhizomes with oleoresin content (0.2898) was found to be the least.

Number of secondary rhizomes

Number of secondary rhizomes was found to have significant effect on rhizome yield. The influence of association of number of secondary rhizomes with other parameters was found to be significantly positive through weight of secondary rhizomes (0.5649), leaf area (0.5530), number of leaves (0.5209), plant height (0.4472), weight of primary rhizomes (0.4335) and plant girth (0.3465). Whereas, the association of secondary rhizomes with number of primary was found to be negative (-0.1607). The correlation of number of secondary rhizomes with oleoresin content (0.1532) was found to be significantly least.

Weight of Primary Rhizomes

Positive and significant association was established through weight of secondary rhizomes (0.8185) followed by number of leaves (0.8119), leaf area (0.8101), number of tillers (0.7658), plant height (0.4999), number of primary rhizomes (0.4766) and number of secondary rhizomes (0.4335). The correlation coefficient of yield as a result of the association with weight of primary rhizomes was found to be 0.8381. The association of weight of primary rhizomes with dry rhizome recovery (0.15588) was found to have least correlation.

Weight of Secondary Rhizomes

Weight of secondary rhizomes had positive and significant association with majority of the characters under consideration. The positive and maximum association of weight of secondary rhizomes was established with number of tillers (0.8874), weight of primary rhizomes (0.8155), leaf area (0.8060), number of leaves (0.7624), plant girth (0.5655), number of secondary rhizomes (0.5649), number of primary rhizomes (0.4889), oleoresin content (0.4084) and dry rhizome recovery (0.3751).

Oleoresin Content (%)

The association of oleoresin was found to significantly affect the rhizome yield. The influence of association of oleoresin content with other parameters was found to be significantly positive through dry rhizome recovery (0.5254) and weight of secondary rhizomes (0.4084). The association of oleoresin content with plant height was found to be significantly least (0.1444).

Dry rhizome recovery (%)

The dry rhizome recovery found to establish significant association with yield through oleoresin content (0.5254) and weight of secondary rhizomes (0.3751). However the association of dry rhizome recovery with weight of primary rhizomes (0.1588) was found to have lesser association.

Yield

The rhizome yield exhibited highly significant and positive correlation with leaf area (0.8501) followed by number of tillers (0.8627), number of leaves (0.8192), weight of primary rhizomes (0.8541), weight of secondary rhizomes (0.8843), plant height (0.5705), number of secondary rhizomes (0.4811), number of primary rhizomes (0.5181) and oleoresin content (0.3519). Dry rhizome recovery were found to have lesser association with rhizome yield (0.3160).

The highly significant influence of weight of secondary rhizomes on rhizome yield might be attributed to its highly significant association with number of leaves, number of tillers, plant girth, leaf area, number of secondary rhizomes, weight of primary rhizomes and weight of secondary rhizomes. Similarly the lesser association of yield with dry rhizome recovery might be due to their non significant association with many of the characters except weight of secondary rhizomes and oleoresin content.

This is due to mutual association between the two traits which might have contributed towards their highly significant positive association with rhizome yield (Laxmi *et al.,* 2017). Similar observations were made by Ravi *et al.,* (2017) and Datta *et al.,* (2006).

Path Analysis

The effectiveness of the association established between different characters under the study could be further studied through the path analysis. This indicates the positive or negative, direct or indirect influence of the independent parameter on the dependent ones. In the present study the path of eleven characters and their association with each other and their direct positive or direct negative influence was assessed (Table 3).

Direct effect

The study revealed that leaf area (0.9428) had direct and positive effect on rhizome yield followed by weight of primary rhizomes (0.3693), number of tillers (0.1684), weight of secondary rhizomes (0.1553), plant height (0.1309), plant girth (0.0654), oleoresin content (0.0622) and dry rhizome recovery (0.0586). However, the direct negative effect on the rhizome yield was observed through the characters such as number of leaves (-0.6312), number of primary rhizomes (-0.1197) and number of secondary rhizomes (-0.1767).

This direct and indirect, cause and effect relation on rhizome yield, indicates that the characters has direct positive influence on leaf area, plant height, number of tillers, weight of primary rhizomes, number of primary rhizomes, number of secondary rhizomes and weight of secondary rhizomes. These characters can be considered for further selection and improvement of the ginger genotypes.

The negative cause and effect relation was induced by number of leaves, number of primary rhizomes and number of secondary rhizomes. Such parameters could not be considered for selection and further crop improvement as their direct effect is observed to be negative on the rhizome yield. Similar observations of direct positive and negative effect inducing characters were also documented by Laxmi *et al.,* (2017).

Table.1 Variability estimates for different growth and yield parameters of ginger genotypes

Characters	Range	Mean	GCV	PCV	h^2	GA	GAM
Plant height	61.48-85.08	70.91	7.5517	14.2493	28.09	5.8464	8.2445
Number of leaves per plant	99.83-282.67	151.34	36.4143	39.4041	85.40	104.9114	69.3220
Number of tillers perplant	11.45-22.45	15.45	19.4740	22.2440	76.64	5.4253	35.1207
Plant girth	3.04-4.00	3.46	7.3549	10.1914	52.08	0.3779	10.9341
Leaf area	9810.52-14186.86	6506.87	49.7738	53.1686	87.64	6245.76	95.9873
Number of primary rhizomes	6.23-7.90	6.82	3.2467	13.4263	5.85	0.1103	1.6174
Number of secondary rhizomes	16.43-22.70	20.06	6.2038	12.5589	24.40	1.2666	6.3129
Weight of primary rhizomes	79.78-118.71	109.45	25.7951	29.8231	74.81	50.3073	45.9610
Weight of secondary rhizomes	32.81-107.49	61.65	34.8872	36.6572	90.58	42.1670	68.3975
Oleoresin content	4.38-9.33	5.98	25.0299	29.6863	71.09	2.6007	43.4739
Dry rhizome recovery	18.55-26.47	22.07	9.9654	13.5576	54.03	3.3304	15.0895
Yield per hectare	1.77-13.54	6.07	51.9211	55.0177	89.06	6.1269	100.9377

GCV – Genotypic coefficient of variation
PCV - Phenotypic coefficient of variation
GA – Genetic Advancement
GAM – Genetic Advancement as % of Mean
h^2 – Broad sense

Table.2 Phenotypic Correlation of growth and yield attributes established with rhizome yield per clump among different ginger genotypes

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1	0.4218*	0.5206**	0.2247	0.4495**	0.3054	0.4472**	0.4999**	0.5544**	0.1444	0.2657	0.5705**
2		1	0.8319**	0.4846**	0.9850**	0.4840*	0.5209**	0.8119**	0.7624**	0.1966	0.2400	0.8192**
3			1	0.5276**	0.8620**	0.4801**	0.5646**	0.7658**	0.8874**	0.2739	0.1874	0.8502**
4				1	0.4982**	0.2534	0.3465*	0.2712	0.5655**	0.3118	0.2757	0.4795**
5					1	0.5185**	0.5530**	0.8101**	0.8060**	0.1975	0.2653	0.8501**
6						1	-0.1607	0.4766**	0.4889**	0.2898	0.3190	0.5181*
7							1	0.4335*	0.5649**	0.1532	0.2094	0.4811**
8								1	0.8185**	0.2969	0.1588	0.8541**
9									1	0.4084*	0.3751*	0.8843**
10										1	0.5254**	0.3519*
11											1	0.3160
12												1

**Significant at 1 % level * Significant at 5% level

1-Plant height
2-Number of leaves per plant
3-Number of tillers per plant
4-Plant girth
5-Leaf area
6-Number of primary rhizomes
7-Number of secondary rhizomes
8-Weight of primary rhizomes
9-Weight of secondary rhizomes
10-Oleoresin content
11-Dry rhizome recovery
12-Yield per clump

Indirect effect

Plant height had positive indirect effect through number of leaves (0.0552), number of tillers (0.0681), plant girth (0.0294), leaf area (0.0588), number of primary rhizomes (0.0400), number of secondary rhizomes (0.0585), weight of primary rhizomes (0.0654), weight of secondary rhizomes (0.0726), oleoresin (0.0189) and dry rhizome recovery (0.0348). Plant height with none of the associations did not establish negative association with rhizome yield. This path indicated the indirect positive effect of plant height on rhizome yield.

Number of leaves had negative indirect effect on plant height (-0.2662), number of tillers (-0.5251), plant girth (-0.3059), leaf area (-0.6217), number of primary rhizomes (-0.3055), number of secondary rhizomes (-0.3288), weight of primary rhizomes (-0.5124), weight of secondary rhizomes (-0.4812), oleoresin content (-0.1241) and dry rhizome recovery (-0.1515). Number of leaves with none of the associations did not establish positive association with that of rhizome yield. This path indicated the indirect positive effect of plant height on rhizome yield.

Number of tillers had positive indirect effect on rhizome yield through plant height (0.0877), number of leaves (0.1401), plant girth (0.0889), leaf area (0.1452), number of primary rhizomes (0.0809), number of secondary rhizomes (0.0951), weight of primary rhizomes (0.1290), weight of secondary rhizomes (0.1495), oleoresin (0.0461) and dry rhizome recovery (0.0316). Number of tillers with none of the associations did not establish negative association with that of rhizome yield. This path indicated the independent positive effect of tillers on rhizome yield.

Plant girth had positive indirect effect on fresh rhizome yield through weight of secondary rhizomes (0.0370), number of tillers (0.0345), leaf area (0.326), number of leaves (0.0317), number of secondary rhizomes (0.0227), oleoresin (0.0204), dry rhizome recovery (0.0180), weight of primary rhizomes (0.0177), number of primary rhizomes (0.0166) and plant height (0.0147). This path indicated the positive indirect effect of plant girth on rhizome yield.

Leaf area had positive indirect effect on rhizome yield through number of leaves (0.9287), number of tillers (0.8127), weight of primary rhizomes (0.7638), weight of secondary rhizomes (0.7599), number of secondary rhizomes (0.5214), number of primary rhizomes (0.4888), plant girth (0.4698), plant height (0.4238), dry rhizome recovery (0.2501) and oleoresin content (0.1862). This path indicated the positive indirect effect of leaf area on rhizome yield.

Number of primary rhizomes had negative indirect effect on plant girth (-0.0303), oleoresin content (-0.0347), plant height (-0.0365), dry rhizome recovery (-0.0382), weight of primary rhizomes (-0.0570), number of tillers (-0.0575), number of leaves (0.0579), weight of secondary rhizomes (-0.0588) and leaf area (-0.0621). Whereas, number of primary rhizome had positive indirect effect on number of secondary rhizomes (0.0192).

Number of secondary rhizomes had indirect positive effect on rhizome yield through number of primary rhizomes (0.0284) and indirect negative effect through oleoresin content (- 0.0271), dry rhizome recovery (-0.0370), plant girth (-0.0612), weight of primary rhizomes (- 0.0766), plant height (-0.0790), number of leaves (-0.0920), leaf area (-0.0977), number of tillers (-0.0998) and weight of secondary rhizomes (-0.0998).

Weight of primary rhizomes had positive indirect effect on rhizome yield through weight of secondary rhizomes (0.3023), number of leaves (0.2999), leaf area (0.2992), number of tillers (0.2828), plant height (0.1846), number of primary rhizomes (0.1760), number of secondary rhizomes (0.1601), oleoresin content (0.1096) plant girth (0.1001) and dry rhizome recovery (0.0587). This path indicated the positive indirect effect of weight of primary rhizomes on rhizome yield.

Weight of secondary rhizomes had positive indirect effect on rhizome yield through number of tillers (0.1378), weight of primary rhizomes (0.1271), leaf area (0.1252), number of leaves (0.1184), plant girth (0.0878), number of secondary rhizomes (0.0877), plant height (0.0861), number of primary rhizomes (0.0759), oleoresin content (0.0634) and dry rhizome recovery (0.0583).

Oleoresin content had indirect positive effect on rhizome yield through dry rhizome recovery (0.0327), weight of secondary rhizomes (0.0254), plant girth (0.0194), number of primary rhizomes (0.0185), weight of primary rhizomes (0.0185), number of tillers (0.0170), number of leaves (0.0122), leaf area (0.0124), number of secondary rhizomes (0.0095) and plant height (0.0090).

Dry rhizome recovery had positive indirect effect on rhizome yield through number of primary rhizomes (0.0187), plant girth (0.0161), plant height (0.0156), leaf area (0.0155), number of leaves (0.0141), number of tillers (0.0110), weight of secondary rhizomes (0.0220), number of secondary rhizomes (0.0123), weight of primary rhizomes (0.0093) and oleoresin (0.0308).

The cause and effect relation of the above set of characters was studied through the path analysis. This indicated a definite path having significantly positive direct or indirect, significantly negative direct or indirect influence on the rhizome yield. The characters leaf area, weight of primary rhizomes, number of tillers, weight of secondary rhizomes, plant height, plant girth oleoresin and dry rhizome recovery had their direct positive influence on the rhizome yield. However, number of leaves, number of primary rhizomes and number of secondary rhizomes had their direct negative influence on the rhizome yield which means except these characters rest of the characters under study would have direct influence on rhizome yield. Hence it was obvious that leaf area, weight of primary rhizomes, number of tillers, weight of secondary rhizomes, plant height, plant girth oleoresin and dry rhizome recovery of the three high yielding genotypes would affect the selection of the genotypes towards increased rhizome yield.

The characters such as plant height, number of primary rhizomes and number of secondary rhizomes, expressed wide difference between GCV and PCV. Rest of the characters such as number of leaves, number of tillers, plant girth, leaf area, weight of primary rhizomes and weight of secondary rhizomes exhibited narrow difference between PCV and GCV. The characters with more PCV than GCV, implies that the characters were under the influence of environment. The selection process based on these characters might not be effective in improving the crop. If the characters with more GCV than PCV, implies that these characters were not influenced by the environment. The selection procedure based on the consideration of these characters would result in effective crop improvement.

The character plant height, number of primary rhizomes and number of secondary rhizomes which expressed low heritability coupled with low genetic advance, which indicates that these characters possess low inheritablility. Hence the selection procedures followed in crop improvement considering these characters might not be effective.

Author Contribution

Netravathi: Investigation, formal analysis, writing—original draft. Shekharagouda Patil: Validation, methodology, writing—reviewing. G. Ramesh:—Formal analysis, writing—review and editing. Ashok Hugar: Investigation, writing—reviewing. B. V. Tembhurne: Resources, investigation writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval: Not applicable.

Consent to Participate: Not applicable.

Consent to Publish: Not applicable.

Conflict of Interest: The authors declare no competing interests.

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