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GENOTYPIC VARIABILITY CORRELATION AND PATH-COEFFICIENT ANALYSIS IN TURMERIC

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The progress in the breeding depends on the heritability of the traits and the extent to which the various characters are inter-related. Selection based on simple correlations without taking into consideration the inter-dependence between traits is often misleading. Path coefficient analysis is widely accepted as a statistical tool to identify desirable traits which merit selection. Though turmeric is one of the important spices which is commercially cultivated in South India very little attention has been given in the past to the study of the genetic behaviour of the crop. The aim of the present investigation is therefore to estimate the important genetic parameters of the crop as a basis of developing reliable selection criteria for yield improvement in turmeric.

Materials and Methods

The data for the study were gathered during 1977-78 from a field trial on turmeric at the College of Horticulture, Vellanikkara, Kerala using randomised block design with four replications and 19 varieties as treatments. The characters included in the study were length of secondary finger (X_1), girth of secondary finger at centre (X_2) number of nodes per secondary finger (X_3), internodal distance of secondary finger (X_4), length of mother rhizome (X_5), number of nodes per mother rhizome (X_6) internodal distance of mother rhizome (X_7), girth of mother rhizome at centre (X_8) number of nodes per primary finger (X_9), length of primary finger (X_{10}), internodal distance of primary finger (X_{11}), girth of primary finger at centre (X_{12}), length of last fully opened leaf (X_{13}), breadth of leaf at centre (X_{14}), petiole length (X_{15}) height of the plant (X_{16}), number of leaves per tiller (X_{17}) and yield of raw rhizome per bed (Y).

Phenotypic and genotypic coefficients of variations were calculated using the formula suggested by Burton (1952). The heritability estimate in the broad sense was calculated by the method proposed by Lush (1949). The expected genetic advance and the expected genetic gain were obtained using the formula suggested by Johnson *et al.* (1955). Path-coefficient analysis was attempted (Dewey and Lu, 1959) and the genotypic correlation coefficients were separated into

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components of direct and indirect effects. Correlation coefeicient was done by using student's t,

$$t = \frac{|\gamma_g|}{(\sigma^2_{\gamma_g})^{\frac{1}{2}}}$$

where $$\sigma^2_{\gamma_g} = \frac{1}{f+1}\left[\tfrac{1}{2}(1-\gamma^2_g)^2 - \tfrac{1}{2}(1-\gamma^2_p)\left(\frac{1}{D} - \frac{\gamma_p\gamma_g}{C}\right) + 4\left(\frac{\gamma_g}{D} - \frac{\gamma_p}{C}\right)^2 + 2\left(1-\gamma^2_g\right)^2 \frac{(1-\gamma^2_p)}{C^2}\right]$$

f = error degrees of freedom

$\frac{1}{D} = \frac{1}{2}\left(\frac{1}{h_x^2} + \frac{1}{h_y^2}\right)$, $C = h_x^2 \times h_y^2$; h_x^2, h_y^2 are the heritability estimates of the characters X and Y respectively.

Results and discussion

Burton (1952) has suggested that genotypic coefficient of variation together with heritability estimates would give the best picture of the amount of advance to be expected from selection. Characters showing low genotypic coefficient of variation indicate that they are seriously affected by environmental modifications. In this study maximum genotypic coefficient of variation was recorded by rhizome yield (42.29%) followed by hight of the plant (17.26%). Genotypic coefficient of variation was minimum in the case of number of nodes per mother rhizome (3.58%). Phenotypic coefficient of variation was highest in case of rhizome yield (58.42%) and that was followed by length of secondary finger (21.54%) and height of the plant (20.61%). In all cases genotypic coefficient of variation was found to be lower than the corresponding phenotypic coefficient of variation indicating the profound influence of environment on the expression of the genotypes.

Characters showing high heritability value could be improved directly through selection since they are less affected by environment. Johnson *et al* (1955) suggested that heritability and genetic advance when calculated and presented together are more useful for predicting the resultant effect of selecting the best individual than heritability or genetic advance alone. High heritability and high genetic gain indicate the presence of additive genetic effects (Panse, 1957). In the present investigation maximum heritability was noticed for girth of mother rhizome (71.48%) followed by plant height (70.11 %). Mohanty (1979) also has reported similar findings. Height of the plant had high heritability and high genetic gain and hence shall be regarded as a suitable character for selecting desirable genotype. The highest genetic advance was observed for height of the plant (10.1837) followed by yield of raw rhizome per bed (9.7576) while the lowest genetic advance was obtained for internodal distance of mother rhizome (0.0214). It was interesting to note that rhizome yield recorded the highest genetic gain (63.06%) with a relatively low heritability value.

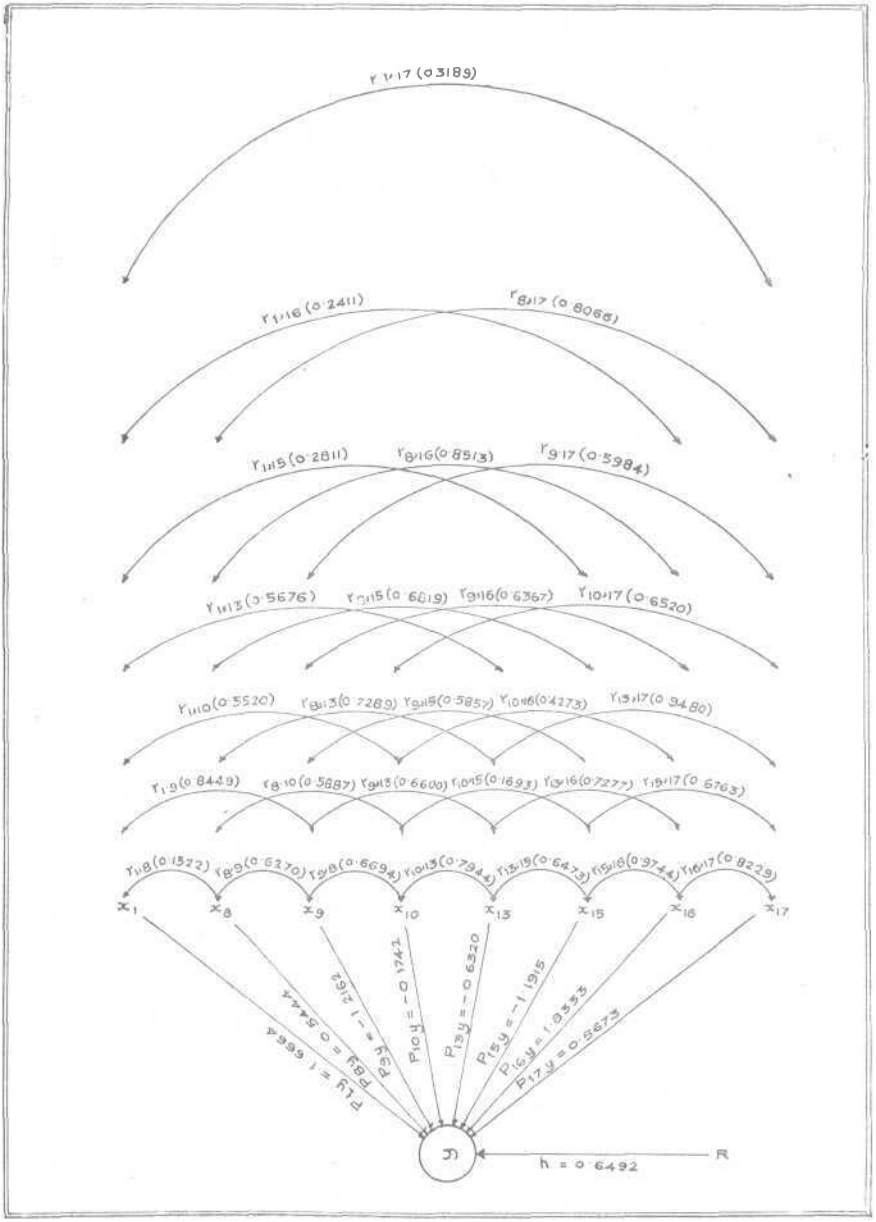

Fig. 1 Cause and effect relationships between yield and other selected biometric characters

Table 1

Estimates of phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in the broad sense (h^2), genetic advance (GA) and genetic gain (GG) under 5% intensity of selection for the eighteen variables in turmeric

Sl. No.	Characters	PCV	GCV	h^2	GA	GG (%)
1	Length of secondary finger	21.54	15.09	0.4908	1.3653	21.78
2	Girth of secondary finger at centre	11.51	792	0.4737	0.7241	11.23
3	Number of nodes per secondary finger	18.89	14.97	0.6277	1.6514	24.43
4	Internodal distance of secondary finger	12.75	7.03	0.3039	0.0737	7.98
5	Length of mother rhizome	13.84	10.13	0.5366	1.6686	15.30
6	Number of nodes per mother rhizome	11.04	3.58	0.1054	0.3287	2.40
7	Internodal distance of mother rhizome	12.15	3.99	0.1076	0.0214	2.69
8	Girth of mother rhizome at centre	13.61	11.50	0.7148	3.0243	20.03
9	Number of nodes per primary finger	10.23	7.04	0.4741	1.0397	9 99
10	Length of primary finger	15.67	11.84	0.5700	1.9140	18.41
11	Internodal distance of primary finger	11.65	8.68	0.5740	0.1341	13.55
12	Girth of primary finger at centre	13.52	8.95	0.4381	1.1137	12.21
13	Length of last fully opened leaf	10.66	7.96	0.5574	7.6328	12.24
14	Breadth of leaf at centre	8.36	4.91	0.3442	0.9631	5.93
15	Petiole length	19.03	12.88	0.4580	5.4194	17.95
16	Height of the plant	20.61	17.26	0.7011	10.1837	29.77
17	Number of leaves per tiller	14.03	10.50	0.5698	0.9214	16.18
18	Yield of raw rhizome per bed	58.42	42.29	0.5240	9.7576	63.06

Table 2

Phenotypic and genotypic correlation coefficients between yield and other characters of turmeric

Sl. No.	Character	Phenotypic correlation	Genotypic correlation
1	Length of secondary finger	0.4905*	0.5513*
2	Girth of secondary finger at centre	0.2956*	0 2150
3	Number of nodes per secondary finger	0.3251*	0.3066
4	Internodal distance of secondary finger	0.3534*	0.3938
5	Length of mother rhizome	0.3058*	04302
6	Number of nodes per mother rhizome	0,0892	0.1704
7	Internodal distance of mother rhizome	0.2937*	0.9237
8	Girth of mother rhizome at centre	0.5152*	0.6783*
9	Number of nodes per primary finger	0.7089*	0.8122*
10	Length of primary finger	06943*	0.7016*
11	Internodal distance of primary finger	0.3557*	0.3252
12	Girth of primary finger at centre	0.4115*	0.4242
13	Length of last fully opened leaf	0.7711*	0.8690*
14	Breadth of leaf at centre	0.3598*	0.5698
15	Petiole length	0.6771*	0.6772*
16	Height of the plant	0.5862*	0 6997*
17	Number of leaves per tiller	0.6762*	0.8143*

* Significant at 5% level

The extent of association between yield and each of the other characters was further investigated. All the characters except the number of nodes per mother rhizome showed statistically significant positive correlations with yield at the phenotypical level. But significant genotypic correlations were noticed for length of secondary finger (0 5513), girth of mother rhizome (0.6783), number of nodes per primary finger (0.8122), length of primary finger (0 7016), length of last fully opened leaf (0.8690), petiole length (0.6672), height of the plant (0.6997) and number of leaves per tiller (0.8143).

From preliminary considerations, eight characters which showed significant genotypic correlations with rhizome yield were selected to conduct path-coefficient analysis. It was observed that height of the plant contributed the maximum positive direct effect towards the rhizome yield (1.8333). This result is in full agreement with the findings of Nambiar (1979). The other characters which exerted positive

Table 3

Path-coefficient analysis in turmeric giving direct and indirect effects of characters on yield

Characters	Length of secondary finger	Girth of mother rhizome at centre	Number of nodes per primary finger	Length of primary finger	Length of last fully opened leaf	Petiole length	Height of the plant	Number of leaves per tiller	Genotypic correlation with yield
Length of secondaryfinger	*1.6664*	0.0829	—1.0312	—0.0961	—0.3587	—0.3349	0.4420	0.1809	0.5513
Girth of mother rhizome atcentre	0.2538	*0,5444*	—0.7625	—0.1025	—0.4606	—0.8125	1.5607	0.4575	0.6783
No. of nodes per primary finger	1.4130	0.3414	—7.2762	—0.1166	—0.4177	—0.6979	1.1673	0.3389	0.8122
Length of primaryfinger	0.9199	0.3205	-08141	*—0.1742*	—-0.5020	—0.2017	0.7834	0.3698	0.7016
Length of last fully opened leaf	0.9459	0,3968	—0.8038	—0.1384	*-0.6320*	—-0.7715	1.3342	0.5378	0.8690
Petiole length	0 4684	0.3713	—-0.7123	—-0.0295	—0.4092	*—1.1915*	1.7864	0.3836	0.6672
Height of the plant	0.4017	0.4635	—0.7743	—0.0744	—0.4599	—1.1610	*1.8333*	0.4708	0.6997
No. of leaves per tiller	0.5314	0.4392	—0.7265	—0.1136	—0.5991	—0.8058	1.5214	*0.5673*	0.8143

Residual effect h = 0.6492

Diagonal entries in italics indicate direct effects of the relevant factors

direct effect on yield were length of secondary finger (1.6664), number of leaves per tiller (0.5673) and girth of mother rhizome at centre (0.5444). The number of nodes per primary finger and petiole length had high negative direct effects (-1 2161 and –1.1915 respectively) on rhizome yield. Direct effects of length of last fully opened leaf (-0.6320) and length of primary finger (—0.1742) on yield were also found to be negative. The high positive genotypic correlations of these characters with yield were mainly due to their indirect effects through height of the plant and length of secondary finger on yield. George (1981) reported that length of primary finger had negative direct effect on rhizome yield in turmeric. All the characters had high positive indirect effects through height of the plant and length of the secondary finger. Thus the study emphasised the importance of the plant height and length of secondary finger in selecting genotypes for further propagation.

Summary

Data on 18 biometric characters of 19 varieties of turmeric gathered from a field trial were analysed and the various genetic parameters estimated. High heritability estimates were manifested by girth of mother rhizome at centre and height of the plant. The expected genetic gain from plant height was also high. The correlation studies revealed that all characters were positively related to yield. Path-coefficient analysis showed height of the plant and length of secondary finger were the major contributors towards the rhizome yield.

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