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Correlation and Path Analysis in Turmeric

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ABSTRACT

Twenty-two turmeric genotypes collected from different parts of the country were evaluated for growth, yield and quality at College of Horticulture, Sirsi, Karnataka, India. The data recorded on different characters were subjected to work out correlation and path analysis to investigate the association, direct and indirect contribution of various characters on fresh rhizome yield per plant. Rhizome yield exhibited highly significant positive association with weight of primary rhizome followed by weight of secondary and mother rhizome, plant height, number of leaves per plant, curing percentage, number of tillers per plant, number of secondary and primary rhizome. Weight of primary rhizome exerted highest positive direct effect on rhizome yield followed by weight of secondary and mother rhizome, number of secondary and primary rhizome, number of leaves per plant, number of tillers per plant and curcumin content. The study revealed that selection for more weight of primary followed by weight of secondary and mother rhizome would be more effective for further improvement of rhizome yield in turmeric as they have maximum positive direct effect as well as highly significant positive association with fresh rhizome yield per plant.

Key words: *Turmeric, Genotype, Rhizome, Correlation, Path.*

INTRODUCTION

Turmeric (*Curcuma longa* L.) is a tropical perennial rhizomatous spice belonging to the family Zingiberacea and native to South East Asia being grown in India since times immemorial. It is regarded as a symbol of well being and widely used in ceremonies and religious functions[3]. Turmeric of commerce is the dried underground rhizome, valued for its deep yellow colour and pungent aromatic flavour due to the presence of colouring matter 'curcumin' and volatile oil 'termerol'. It is also an important condiment which finds a unique place in culinary arts and as colouring agent in textile, food, confectionary, cosmetics and drug industries, of late in the preparation of anticancer medicines. In India, it is mainly grown in Tamil Nadu, Telangana, Andhra Pradesh, Assam, West Bengal, Orissa, Karnataka, Maharashtra, Bihar and Kerala. The national productivity of crop is 5.1 tons per hectare[2].

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In Karnataka, turmeric is being cultivated in Belgaum, Chamarajnagara, Uttar Kannada, Hassan, Shimoga and Chickmagalore are important districts growing turmeric. In Malnad (Hilly Region) the crop is mainly cultivated under rainfed conditions, taking the advantage of high rainfall, better distribution from June to October. There are large number of cultivars available in turmeric and considerable variability exists with regard to morphological and yield characters and several attempts have been made to assess this variability[4,13].

Variability studies provide information on the extent of improvement could be achieved in different characters, but they do not throw light on the extent and nature of relationship existing between various characters. Therefore, for rational approach towards the improvement of yield, selection has to be made for the components of yield, since there may not be genes for yield *per se*, but only for various yield components. Further, many of these yield contributing characters may interact in desirable and undesirable direction. Hence, a knowledge regarding the association of various characters among themselves and with economic characters is essential. The path analysis suggested by Dewey and Lu[5] provides an effective measure of direct and indirect causes of association and depicts the relative importance of each factor involved in contributing to the final product i.e., yield. The present investigation was, therefore, conducted to find out the major yield contributing traits in turmeric.

MATERIAL AND METHODS

An experiment was conducted at College of Horticulture, Sirsi during 2015-2016 to evaluate twenty-two turmeric genotypes in a complete randomize block design with three replications. Turmeric rhizome was planted in the month of May on raised bed of 3m × 1m size, by adopting spacing of 30cm × 20cm. Standard agronomic and plant protection measures were carried out to raise the healthy crop. Observations were recorded on five random plants from each replication for growth, yield and quality attributes. Data on eleven characters *viz*. plant height, number of leaves and tillers per plant, number of primary and secondary rhizome, weight of mother, primary and secondary rhizome, curcumin content, curing percentage and fresh rhizome yield per plant was recorded and the mean values were subjected to correlation[1] and path analysis[5]. Plant height, number of leaves and tillers per plant were recorded at the maximum vegetative growth stage (180 days after planting) and rhizome characters were recorded at the time of harvest.

RESULT AND DISCUSSION

The phenotypic and genotypic correlations were estimated among eleven characters to determine the nature of association existing between rhizome yield per plant and its component characters and the results are presented in Table 1. Rhizome yield exhibited highly significant positive association with weight of primary rhizome (p=0.928; g=984) followed by weight of secondary rhizome (p=0.924; g=957), weight of mother rhizome (p=0.767; g=859), plant height (p=0.720; g=0.803), number of leaves per plant (p=0.663; g=0.798), curing percentage (p=0.616; g=0.751) and number of tillers per plant (p=0.546; g=0.658), while it registered nonsignificant correlation with curcumin content (p=0.013; g=0.020) both at phenotypic and genotypic levels. Venkatesh[15], Hazra *et al*[6]., Yadav *et al*[17]., and Verma *et al*[16]., have

also reported that the characters like weight of primary, secondary and mother rhizome showed highly significant positive correlation with rhizome yield in turmeric. Number of primary and secondary rhizome exerted significant positive association with rhizome yield at phenotypic level, while highly significant positive association at genotypic level. Suchand *et al*[14]., found significant correlations of number of primary and secondary rhizome with plant height in turmeric. Similar observation were noticed under present study. Significant and positive association of the traits with rhizome yield was reported by Panja *et al*[7]., at genotypic level in turmeric, while Rajyalakshmi and Umajyothi[9] at both genotypic and phenotypic level in ginger. Mutual association between the two traits at genotypic level might be contributing towards their highly significant positive association with rhizome yield. Curing percentage showed highly significant positive association with rhizome yield. Verma *et al*[16]., reported similar results. Curcumin content had non-significant association with rhizome yield. Roa *et al*[11]., reported the negative correlation of the trait with cured rhizome yield.

In order to get the developmental relations, the cause and effect relationship between yield *per se* and ten yield components were investigated through path coefficient analysis. As the genotypic association is inherent, the results of path analysis are discussed only at genotypic level (Table 2). Weight of primary rhizome exerted the highest positive direct effect (0.683) on rhizome yield followed by weight of secondary rhizome (0.284), weight of mother rhizome (0.099), number of secondary rhizome (0.097) and number of primary rhizome (0.070). Similarly, Yadav *et al*[17]., reported weight of primary rhizome exhibited highest positive direct effect (0.600) on rhizome yield followed by weight of secondary rhizome (0.409), weight of mother rhizome (0.122), number of primary rhizome (0.015) and number of secondary rhizome (0.002) in turmeric. Number of primary rhizome recorded positive direct effect on rhizome yield and was due to positive indirect effect of the trait on rhizome yield via number of secondary rhizome, weight of primary and secondary rhizome, while number of secondary rhizome showed a positive direct effect which was responsible for its positive association with rhizome yield. Its indirect effects through number of primary rhizome and plant height noticed positive on rhizome yield. Yadav *et al*[17]., reported similar results in turmeric under Meghalaya conditions. Curing percentage recorded negative direct effect (-0.054) on rhizome yield. Similar observation was noticed by Singh and Ramakrishna[12] in turmeric. However, its positive correlation with rhizome yield was mainly attributed to its indirect effect through number of tillers per plant (0.028) and number of leaves per plant (0.026). The direct effect of curcumin content was low (0.019). Its direct effect through other characters was also low. Hence, low association (0.020) was mainly due to its low direct effect on rhizome yield. Rao *et al*[10]., reported curcumin content had low direct effect at phenotypic level and high direct effect at genotypic level with cured rhizome yield. The results are also in accordance with the findings of Prajapati *et al*[8]., in turmeric. Thus it can be concluded that, characters like weight of primary, secondary and mother rhizome which exhibit maximum direct effect and highly significant positive association with rhizome yield should be used as selection criterion for further improvement of rhizome yield in turmeric.

Table 1: Phenotypic and genotypic correlation coefficients among rhizome yield and its component characters in turmeric genotypes

Characters		X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
X_1	p	0.670**	0.582**	0.630**	0.598**	0.598**	0.623**	0.704**	-0.020	0.453*	0.720**
	g	0.836	0.811**	0.739**	0.702**	0.696**	0.749**	0.819**	-0.038	0.681**	0.803**
X_2	p		0.541**	0.445*	0.443*	0.634**	0.572**	0.626**	0.125	0.280	0.663**
	g		0.886**	0.578**	0.623**	0.803**	0.713**	0.765**	0.139	0.495*	0.798**
X_3	p			0.450*	0.288	0.457*	0.475*	0.498*	-0.069	0.358	0.546**
	g			0.546**	0.433*	0.589**	0.634**	0.627**	-0.105	0.518*	0.658**
X_4	p				0.529*	0.510*	0.446*	0.464*	0.063	0.468*	0.523*
	g				0.713**	0.571**	0.583**	0.544**	0.035	0.637**	0.581**
X_5	p					0.526*	0.410	0.558**	0.053	0.464*	0.523*
	g					0.619**	0.508*	0.685**	0.103	0.656**	0.625**
X_6	p						0.675**	0.718**	0.072	0.506*	0.767**
	g						0.785**	0.796**	0.069	0.710**	0.859**
X_7	p							0.786**	-0.041	0.601**	0.928**
	g							0.864**	-0.040	0.759**	0.984**
X_8	p								0.020	0.526*	0.924**
	g								0.036	0.676**	0.957**
X_9	p									0.023	0.013
	g									0.037	0.020
X_{10}	p										0.616**
	g										0.751**

* Significant at 5 per cent level; ** Significant at 1 per cent level; ± Table 'r' at 5%=0.423 1%=0.537; p-penotypic level ; g-genotypic level

Where,

X_1 – Plant height (cm)
X_2 – Number of leaves per plant
X_3 – Number of tillers per plant
X_4 – Number of primary rhizome
X_5 – Number of secondary rhizome
X_6 – Weight of mother rhizome (g)
X_7 – Weight of primary rhizome (g)
X_8 – Weight of secondary rhizome (g)
X_9 – Curcumin content (%)
X_{10} – Curing percentage
X_{11} – Rhizome yield per plant (g)

Table 2: Genotypic path coefficient analysis of rhizome yield and its component characters in turmeric genotypes

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	'r' with rhizome yield
X_1	**-0.015**	0.013	0.012	-0.012	-0.011	-0.011	-0.012	-0.013	0.001	-0.011	0.803**
X_2	0.026	**0.032**	0.028	0.019	0.020	0.026	0.023	0.024	0.004	0.016	0.798**
X_3	0.017	0.019	**0.021**	0.012	0.009	0.012	0.015	0.013	0.002	0.001	0.658**
X_4	-0.052	-0.041	-0.038	**0.070**	0.050	-0.040	0.041	0.038	-0.002	-0.045	0.581**
X_5	0.068	0.061	0.042	0.069	**0.097**	0.060	0.049	0.067	0.010	0.064	0.625**
X_6	0.069	0.079	0.058	0.056	0.061	**0.099**	0.077	0.078	0.007	0.070	0.859**
X_7	0.511	0.487	0.433	0.398	0.347	0.536	**0.683**	0.590	-0.027	0.518	0.984**
X_8	0.233	0.217	0.178	0.154	0.195	0.226	0.246	**0.284**	0.010	0.192	0.957**
X_9	-0.001	0.003	-0.002	0.001	0.002	0.001	-0.001	0.001	**0.019**	0.001	0.020
X_{10}	-0.037	0.026	0.028	-0.034	-0.035	-0.038	-0.041	-0.036	-0.002	**-0.054**	0.751**

Residual effect= 0.020

The main diagonals (bold) are direct effects.

* Significant at 5 per cent level ** Significant at 1 per cent level

Where,

X_1 – Plant height (cm)
X_2 – Number of leaves per plant
X_3 – Number of tillers per plant
X_4 – Number of primary rhizome
X_5 – Number of secondary rhizome
X_6 – Weight of mother rhizome (g)
X_7 – Weight of primary rhizome (g)
X_8 – Weight of secondary rhizome (g)
X_9 – Curcumin content (%)
X_{10} – Curing percentage

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