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Genetic association among different characters in tobacco (*Nicotiana rustica* L.)

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Abstract
Forty genotypes of tobacco (*Nicotiana rustica* L.) studied for correlations and path analysis during 2012-13. The estimates of correlation coefficient revealed that cured leaf yield was positively correlated at both genotypic and phenotypic levels with days to flowering, number of leaves per plant, plant height, days to maturity, leaf length and leaf width, while it was negatively correlated with leaf thickness and reducing sugar content. Path analysis based on genotypic correlation showed that number of leaves per plant, plant height and leaf length are important characters that exerted considerable direct effect on cured leaf yield revealing scope for considering these characters in selection programme for bringing out desired improvement in tobacco yield.

Keywords: Tobacco, correlation, path coefficient and *Nicotiana* spp.

1. Introduction
Tobacco is a *Solanaceous* crop and belongs to the genus *Nicotiana*. Out of 66 species of *Nicotiana*, only two species *viz.*, *tabacum* and *rustica* are under cultivation**.** The *Nicotiana rustica* varieties known as *Vilayati* and *Calcuttia are* characterized by short plant with puckered leaf and yellow flowers, and are mainly used for only chewing, hookah and snuff tobaccos. India, Bangladesh and Pakistan are the major producer of Hookah and chewing tobacco (*Nicotiana rustica* L.). Tobacco is one of the most important cash crop in middle Gujarat region. The objective of this study was to work out yield and yield component relationships in rustica tobacco using path-coefficient analysis. Different quantitative character governs the yield of a crop. Study of yield and association between pair of these characters provide basis for further selection. Further, the response is determined by the type of genetic divergence involved in the expression of a trait.

2. Materials and Methods
The experimental material comprised of forty genotypes of *rustica* tobacco from the genetic stock collection at Bidi Tobacco Research Station, Anand Agricultural University, Anand were grown in a randomized block design, replicated three times during 2012-13. Each plot consisted of single row of ten plants with inter and intra row spacing of 90 cm and 75 cm, respectively. The guard row was provided on all sides of each block. The tillage operations and interculturing were done in accordance with recommended practices. Five competitive plants were randomly selected from each plot and tagged. Observations for each plant were recorded separately and average value plant/plot was computed. Phenotypic and genetic correlation coefficients for cured leaf yield were calculated for each pair of traits as described by Singh and Choudhary (1985). Correlation coefficients for cured leaf yield were further subjected to path-coefficient analysis and direct and indirect effects were estimated as suggested by Write (1921) [13].

3. Results & Discussion
The correlation coefficient analysis was used to determine the type and magnitude of association between all possible pairs among the characters under study. The association between characters that can be directly observed is phenotypic correlation and it includes the actual correlation excludes the environmental effect and is used in strengthening the interpretation based on phenotypic correlation.
The significant and positive genotypic and phenotypic correlation was found for cured leaf yield with number of leaves per plant, leaf length, leaf width, plant height, days to flowering and days to maturity (Table 1). From correlation results, it was clear that almost all growth parameters are positively correlated. Cured leaf yield which was significantly associated with days to flowering and number of leaves per plant suggested that late maturing genotypes

would be higher yielding but such association may be prove to be limitation in breeding high yielding early varieties.

The significant and positive correlation observed for number of leaves and plant height with cured leaf yield suggested that leaves per plant and plant height is good index for isolating high yielding varieties. Correlation between cured leaf yield and leaf length and leaf width was also reported by Amarnath and Murty (1988) [1], Dobhal and Rao (1988) [6], Cho and Jin (1989) [3], Patel (1989) [11], Datta (2002) [4], Patel and Makwana (2002) [9], Patel and Kingaonkar (2005) [10] and Nama (2011) [8]. Correlation between cured leaf yield and number of leaves was also in accordance with of Patel (1989) [11], Chaubey *et al*., (1990) [2], Datta (2002) [4], Patel and Makwana (2002) [9], Patel and Kingaonkar (2005) [10] and Nama (2011) [8]. Correlation between cured leaf yield and plant height was also reported by Patel and Makwana (2002) [9], Datta (2002) [4], Patel and Kingaonkar (2005) [10] and Nama (2011) [8]. Correlation between cured leaf yield and days to flowering were also in accordance with Datta (2002) [4], Patel and Makwana (2002) [9], Patel and Kingaonkar (2005) [10] and Nama (2011) [8]. Correlation between cured leaf yield and days to maturity was akin to the finding of Patel and Makwana (2002) [9], Patel and Kingaonkar (2005) [10] and Nama (2011) [8].

Table 1: Genotypic and Phenotypic correlation coefficient for different characters

Characters		Days to flowering	No. of leaves /plant	Plant height (cm)	Days to maturity	Leaf length (cm)	Leaf width (cm)	Leaf thickness (g/cm^2)	Nicotine content (%)	Reducing sugar content (%)	Chloride content (%)
Cured leaf yield (g/plant)	r_g	0.693**	0.896**	0.804**	0.475**	0.870**	0.783**	-0.924**	0.018	-0.445**	0.202
	r_p	0.602**	0.874**	0.777**	0.441**	0.812**	0.743**	-0.883**	0.011	-0.426**	0.194
Days to flowering	r_g		0.772**	0.547**	0.570**	0.649**	0.597**	-0.532**	-0.040	-0.421**	0.184
	r_p		0.759**	0.525**	0.533**	0.613**	0.560**	-0.509**	-0.042	-0.397**	0.172
No of leaves/plant	r_g			0.683**	0.586**	0.797**	0.784**	-0.821**	-0.013	-0.467**	0.290
	r_p			0.649**	0.544**	0.750**	0.703**	-0.784**	-0.026	-0.434**	0.271*
Plant height (cm)	r_g				0.378*	0.662**	0.543**	-0.725**	0.021	-0.412**	0.098
	r_p				0.346**	0.606**	0.511**	-0.692**	0.032	-0.378**	0.075
Days to maturity	r_g					0.493**	0.525**	-0.323*	-0.487**	-0.282	-0.049
	r_p					0.447**	0.493**	-0.279*	-0.371**	-0.266*	-0.046
Leaf length (cm)	r_g						0.845**	-0.743**	0.096	-0.454**	0.280
	r_p						0.764**	-0.677**	0.071	-0.413**	0.27*
Leaf width (cm)	r_g							-0.651**	0.057	-0.385*	0.261
	r_p							-0.606**	0.014	-0.359**	0.226*
Leaf thickness (g/cm^2)	r_g								-0.010	0.450**	-0.293
	r_p								-0.016	0.405**	-0.262**
Nicotine content (%)	r_g									0.113	0.138
	r_p									0.078	0.110
Reducing sugar content (%)	r_g										-0.187
	r_p										-0.173

*, ** significant at 5% and 1% level of significance, respectively.

Table 2: Path-coefficient analysis for direct and indirect effects of different characters on cured leaf yield.

Sr. No.	Days to flowering	No. of leaves /plant	Plant height (cm)	Days to maturity	Leaf length (cm)	Leaf width (cm)	Leaf thickness (g/cm^2)	Nicotine content (%)	Reducing sugar content (%)	Chloride content (%)	Genotypic correlation with yield
Days to flowering	-0.055	0.222	0.092	-0.019	0.160	0.057	0.217	0.001	-0.019	-0.017	0.693**
No. of leaves /plant	-0.043	0.287	0.114	-0.020	0.197	0.072	0.335	-	-0.021	-0.026	0.896**
Plant height (cm)	-0.030	0.196	0.167	-0.013	0.163	0.052	0.296	-0.001	-0.018	-0.009	0.804**
Days to maturity	-0.032	0.168	0.063	-0.033	0.122	0.050	0.132	0.013	-0.012	0.004	0.475**
Leaf length (cm)	-0.036	0.229	0.111	-0.017	0.247	0.081	0.303	-0.003	-0.020	-0.025	0.870**
Leaf width (cm)	0.033	0.215	0.091	-0.018	0.208	0.096	0.266	-0.002	-0.017	-0.024	0.783**
Leaf thickness (g/cm^2)	0.029	-0.236	-0.121	0.011	-0.183	-0.062	-0.408	-	0.020	0.027	-0.924**
Nicotine content (%)	0.002	-0.004	0.004	0.016	0.024	0.006	0.004	-0.026	0.005	-0.012	0.018
Reducing sugar content (%)	0.023	-0.134	-0.069	0.009	-0.112	-0.037	-0.184	-0.003	0.044	0.017	-0.445**
Chloride content (%)	-0.010	0.083	0.016	0.002	0.069	0.025	0.120	-0.004	-0.008	-0.091	0.202

The significant negative association was observed between leaf thickness and reducing sugar content. Nicotine content and chloride content showed non-significant association with this trait. Under this situation when yield and quality had negative association there is a need for balancing yield and quality characters. Correlation between cured leaf yield and leaf thickness was also accordance with Datta (2002) [4] and Patel and Makwana (2002) [9]. Correlation between cured leaf yield and reducing sugar content was also in accordance with Datta (2002) [4] and Nama (2011) [8].

Path coefficient analysis is useful in determining the direct and indirect effect among various attributes. The result revealed that days to flowering, number of leaves per plant, plant height, days to maturity, leaf length and leaf width had positive and significant association with cured leaf yield at genotypic level (Table 2). Similar result was also reported by Cho and Jin (1989) [3], Patel (1989) [11], Amarnath and Murthy (1988) [1], Datta (2002) [4], Patel and Makwana (2002) [9], Patel and Kingaonkar (2005) [10] and Nama (2011) [8].

Leaf thickness and reducing sugar content had negative significant association with cured leaf yield as mentioned earlier in correlation analysis. The result for Leaf thickness and reducing sugar content is in accordance to reports of Dobhal and Monga (1989), Datta (2002) [4], Patel and Makwana (2002) [9] and Nama (2011) [8].

The result revealed that the number of leaves per plant showed positive and significant association with cured leaf yield, its direct effect being positive and profound as compared to other traits, which was supported by an indirect effect through leaf thickness, leaf length and plant height. The present findings were in accordance to those of Dobhal and Rao (1988) [6], Kara and Essendal (1996) [7], Patel and Kingaonkar (2005) [10] and Nama (2011) [8].

Significant and positive correlation between plant height and cured leaf yield was observed. Plant height had high direct effect *via* number of leaves per plant, leaf length and leaf thickness. The present findings were in accordance to Patel and Makwana (2002) [9].

Significant and positive correlation of leaf length with cured leaf yield was accounted for by it positive direct effect and high indirect effects *via* number of leaves per plant, plant height and leaf thickness. The result for leaf length with cured leaf yield was in accordance to reports of Amarnath and Murthy (1988) [1], Dobhal and Rao (1988) [6], Datta (2002) [4], Patel and Makwana (2002) [9] and Nama (2011) [8].

Leaf width had very little direct effect, however positive correlation with cured leaf yield was caused due to indirect effect of leaf length, number of leaves per plant and leaf thickness. Similar result was also been reported by Dobhal and Rao (1988) [6], Patel and Makwana (2002) [9] and Patel and Kingaonkar (2005) [10]

The overall path analysis based on genotypic correlation revealed that curable number of leaves per plant, plant height, leaf length and leaf width are the strongest forces influencing cured leaf yield. Hence selection based on number of leaves per plant, plant height, leaf length and leaf width may useful for bringing out genetic improvement in the cured leaf yield of tobacco.

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