Line × Tester Studies in Flue-Cured Virginia Tobacco*

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ABSTRACT

The combining ability and gene effects of developmental and agronomic traits of the FCV tobacco were studied using 12 fertile cultivars, two male-sterile lines and their 24 hybrids. The general combining ability variance component of males was significant for leaf length, breadth and thickness; bright leaf yield, TBLE and leaf curl disease incidence. The general combining ability variance of females was significant for number of suckers, leaf breadth and tobacco mosaic virus disease incidence. The specific combining ability variance was significant for weight of suckers only. Nonadditive effects were primarily involved for internode length, weight of suckers, leaf area and chloride content, while both additive and nonadditive effects governed the expression of number of suckers, leaf length, breadth and thickness; bright leaf yield and TBLE. The tobacco mosaic virus and leaf curl disease characters were governed by additive effects. *(Received on July 16, 1975).*

INTRODUCTION

THE availability of cytoplasmic-genetic male-sterile lines (Chaplin, 1969) has hastened the feasibility of commercial cultivation of hybrid tobacco. Burley tobacco hybrids are currently being grown in the USA, but the Flue-Cured Virginia (FCV) tobacco hybrids are still under observations in order to put them on commercial footing. Isolation of varieties that will contribute favourable gene(s) for yield and quality is an essential step in the scientific development of FCV tobacco hybrids. The combining ability and gene action of developmental and agronomic traits of the FCV tobacco have been studied by many workers like Matzinger (1959), Matzinger, Mann and Robinson (1960), Matzinger *et al.* (1962), Legg, Matzinger and Mann (1965) Murty (1965), Chang (1966), Chaplin (1966), Gwynn (1966), Matzinger (1968) and Vandenberg and Matzinger (1970) using fertile × fertile FCV crosses. The object of this study is to determine the combining ability of 12 fertile and two male-sterile FCV tobacco varieties for various characters.

METHODS

The experimental material consisted of two male-sterile lines (PDMS 1 and PDMS 2) used as female parents, a set of 12 male parents (Bonanza, Delcrest, Golden wilt, Yellow Special, NC

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73, NC 75, NC 95, SC 66, HR 62-7, CTRI Special, Special FCV and line 1-99-83-14 and their 24 hybrids. The F_1 seeds were produced by hand pollination. The experimental material was grown during 1973-74 in a randomised block design using two replications. Each plot had two rows of 12 plants each, the inter and intra row spacing being one m and 0.5 m, respectively. The border plots were provided with guard rows.

The characters studied were as under:

(1) Days to flower were recorded by counting the days from transplanting to the opening of first flower. (2) Plant height was measured in cm from ground level to the crow-foot. (3) Internode length was derived by dividing plant height by total number of nodes. (4) Number of suckers was derived by counting all suckers of individual plant. (5) Weight of suckers was computed by weighing (in g) all fresh suckers. (6) Number of leaves harvested per plant were counted. (7) Leaf length was measured (in cm) from leaf base to leaf tip. (8) Leaf breadth was measured (in cm) in the maximum expanded region of the leaf. (9) Leaf area was measured with the help of a frame calibrated in sq cm. (10) Leaf thickness was calculated (mg/cm^2) by dividing the dry weight of leaves by total leaf area. (11) Green leaf yield was determined by weighing (in g) all leaves, harvested per priming and summing up the weights. (12) Cured leaf yield was determined by weighing (in g) the entire produce of each plot after curing. (13) Bright leaf yield represented the top grades of cured leaf with bright yellow, orange colour or little blemish having high commercial value. (14) Total Bright Leaf Equivalent (TBLE) an indication of quality was calculated by using the formula, TBLE= (bright leaf yield)+0.465 (medium grades), where medium grades comprised light bright yellow and light green grades. (15) Chloride content of the samples was determined by electrotitrimetric procedure (Murty *et al.* 1962). Entrywise entire population was scored at flowering stage for natural incidence of (16) Tobacco Mosaic Virus (TMV) and (17) Leaf curl diseases.

For the study of characters 1 to 10, five plants were selected at random from each plot. The observations were recorded on individual plant basis and the mean value per plot was computed. From the middle portion of each of the five plants selected at rondom three, leaves were selected for the study of characters 7 through 10 and the mean value per plot was computed. The produce of the entire plot was taken into consideration for traits 11 to 14. For chloride estimation, samples of cured leaves were taken from alternate primings beginning with second priming from the entire produce on plot basis.

The statistical analysis of all traits was done as suggested by Steel and Torrie (1960) and the mean squares for males, females and males × females were used for estimating the general combining ability of males (g_i) and females (g_j) as well as the specific combining ability (s_{ij}) using the method suggested by Beil and Atkins (1967) with necessary modifications. The males used in this

study were considered as random effects representing the FCV population, whereas the two females were considered as the fixed effects. Hence, the expectation of mean squares for mixed model have been used.

RESULTS AND DISCUSSION

Among males the g_i variance component was significant for leaf length, leaf breadth, leaf thickness, bright leaf yield, the TBLE and leaf curl disease incidence traits (Table 1). NC 73 was found to

TABLE—1

Variance components for general and specific combining ability obtained from the F_1 hybrids and for parents *vs* hybrids.

Characters	$\hat{\sigma}^2_{g_i}$	$\hat{\sigma}^2_{g_j}$	$\hat{\sigma}^2_{s_{ij}}$	σ^2 *Parents vs Hybrids*
Days to flower	–5.00	–2.29	11.66	349.63
Plant height	25.45	30.55	73.31	380.67
Internode length	0.03	0.10	0.04	5.80**
Number of suckers	0.05	0.25*	0.14	21.33**
Weight of suckers	594.38	–352.88	2536.99*	62619.05**
Number of leaves	0.27	0.85	0.90	0.10
Leaf length	3.42*	–0.18	–1.98	79.22**
Leaf breadth	1.01*	0.83*	0.59	25.52**
Leaf area	33.19	11.75	54.02	2830.72**
Leaf thickness	9.80**	–0.07	–1.96	114.27*
Green leaf yield	23227.07	28844.93	907399.98	4214827.02
Cured leaf yield	7044.91	16803.13	45001.09	205723.31
Bright leaf yield	42937.63**	8707.94	9106.87	247939.57*
TBLE	21924.88*	3839.99	23045.18	445302.18*
Chloride content				
Second priming	0.02	0.01	0.01	0.82*
Fourth priming	0.01	–0.03	–0.05	0.15
Sixth priming	–0.35	0.07	0.09	0.02
Eighth priming	0.12	0.05	–0.02	0.13
Tobacco mosaic virus	0.05	0.77**	–0.05	0.32
Leaf curl	0.07*	–0.004	–0.02	0.01

be a good donor for leaf length, leaf breadth and the TBLE, whereas NC 95 was found to have good general combining ability to impart thinness to the leaf, a desired feature for the FCV tobacco (Table 2). From bright leaf yield view point, delcrest was found to be a good donor. Though none of the parents or hybrids were free from leaf curl incidence under field conditions, HR 62-7 was found to be a better parent to be selected from the male parents used in the study for hybridization work to partly keep the leaf curl incidence at low level.

TABLE—2

Estimates of relative general combining ability effects of tobacco traits having significant $\hat{g}_i$ and $\hat{g}_j$ variances.

Parents	*Characters*							
	Number of suckers	*Leaf length*	*Leaf breadth*	*Leaf thickness*	*Bright leaf yield*	*TBLE*	*Tobacco mosaic virus incidence*	*Leaf curl incidence*
Males				$\hat{g}_i$				
Bonanza		–1.14	–0.84	–0.48	–163	–85		–0.44
Delcrest		0.17	–0.50	0.40	168	123		–0.05
Golden Wilt		0.29	0.53	–2.33	71	41		0.06
Yellow Special		–6.18	–2.07	10.61	–695	–556		–0.31
NC 73		4.07	2.96	–0.61	26	174		–0.02
NC 75		0.29	0.78	–1.65	82	40		0.06
NC 95		0.96	1.38	–4.56	80	106		0.33
SC 66		1.34	0.08	–3.29	151	165		–0.15
HR 62–7		–0.86	0.15	–0.30	113	38		–0.53
CTRI Special		–0.56	–1.24	1.36	–19	–108		0.41
Special FCV		–0.46	0.13	1.61	146	38		0.68
1–9–83–14		2.07	–1.27	–0.35	45	21		0.01
Females				$\hat{g}_j$				
PDMS 1	–0.4		–0.71				0.20	
PDMS 2	0.4		0.72				–0.21	

The g_j variance component of females was significant for number of suckers, leaf breadth and tobacco mosaic virus disease incidence trait (Table 1). Between the PDMS 1 and the PDMS 2 the former male–sterile line having tendency to produce minimum suckers was found to be a good donor for number of suckers, whereas the latter line was found to have good general combining ability for leaf breadth and to keep tobacco mosaic virus incidence at low level under field conditions (Table 2). The s_{ij} variance component was significant for weight of suckers (Table 1) and the hybrid PDMS 1 × Yellow Special had minimum sucker weight (Table 3). The femlae parent of this hybrid was also a good donor for poor sucker production. The PDMS 2 × Yellow Special hybrid had maximum value for specific combining ability for weight of suckers.

The presence of significant general and specific combining ability variances for number of suckers have been reported by Matzinger *et al.* (1962), whereas Chaplin (1966) could find only the general combining ability variance for this trait in the FCV tobacco. Matzinger *et al.* (1962), and Vandenberg and

TABLE—3

Estimates of relative specific combining ability $\hat{S}_{ij}$ effect for weight of suckers.

Females	*Males*											
	Bonanza	*Delcrest*	*Golden Wilt*	*Yellow Special*	*NC 73*	*NC 75*	*NC 95*	*SC 66*	*HR 62-7*	*CTRI Special*	*Special FCV*	*1-99-83-14*
PDMS 1	-28	-10	50	-100	5	40	36	14	-20	-35	-22	70
PDMS 2	28	9	-51	100	-6	-41	-36	-14	20	35	21	-71

Matzinger (1970) have reported significant general combining ability variance for leaf length and breadth of the FCV tobacco. Significant general combining ability variance for the FCV leaf quality has been observed by Matzinger *et al* (1962), Chang (1966), Chaplin (1966) and Gwynn (1966), whereas Vandenberg and Matzinger (1970) reported the presence of both general and specific combining ability variances for this trait.

The g_i, g_j and s_{ij} variance components for days to flower, plant height, internode length, number of leaves, leaf area, green leaf yield, cured leaf yield, chloride content in the produce of the second, fourth, sixth and eighth primings; the g_i variance compoent for number of suckers, weight of suckers and tobacco mosaic virus incidence; the g_j variance component for weight of suckers, leaf length, leaf thickness, bright leaf yield, the TBLE and leaf curl incidence and the s_{ij} variance component for number of suckers, leaf length, leaf breadth, leaf thickness, bright leaf yield, the TBLE, and tobacco mosaic virus and leaf curl incidences were nonsignificant.

The ratio of the sum of the variance components for general combining ability of males and females of those of the specific effects as well as the parents *vs* hybrids comparision (Table 1) revealed that nonadditive effects were primarily involved in the expression of internode length, weight of suckers, leaf area and chloride content in the produce of second priming, whereas both additive as well as nonadditive effects were involved in the expression of number of suckers, leaf length, leaf breadth, leaf thickness, bright leaf yield, and TBLE. For tobacco mosaic virus and leaf curl traits, additive effects were primarily involved.

Presence of additive variance for number of suckers (Matzinger, 1959; 1968), additive x additive (Matzinger *et al.* 1960) and additive genetic variances (Legg *et al.* 1965; Matzinger, 1968) for leaf length and additive variance for leaf breadth (Matzinger *et al.* 1960; Legg *et al.* 1965; Matzinger, 1968); and leaf quality (Matzinger, 1968) have been reported.

In summary, among the male lines studied, NC 73 showed good general combining ability for leaf length and breadth, and TBLE, whereas NC 95 was a good donor for leaf thinness. For bright leaf yield, delcrest was found to be a good donor. Between two male-sterile lines PDMS 1 and PDMS 2 studied, former was relatively shy for sucker production in hybrid combinations, while

the latter was a good donor for leaf breath. The PDMS 1 × Yellow Special hybrid had minimum sucker weight.

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