

A PARTIAL CHLOROPHYLL DEFICIENCY IN *NICOTIANA TABACUM* L.

REPORTS of spontaneous occurrence of mutants for different degrees of chlorophyll-deficiency in the cultivated species of *Nicotiana* and *N. tabacum* in particular are not as frequent as in the other related genera.^{1, 2} In a group of flue-cured tobacco varieties obtained from China a variety 'Kwang' was found to possess yellow leaves from the early stages of growth.³ The leaves turned green with the onset of reproduction. Since such partial chlorophyll deficient types are of interest in the development of flue-cured strains suitable for the heavy soils where proper ripening of the leaf is a problem, a genetic study of this character was undertaken. This paper summarises the results of this study.

The variety Kwang was crossed with Chatham which is a flue-cured variety with normal green leaves. The F_1 was normal. The segregation in the F_2 and back-crosses is presented in Table I.

The counts of seedlings were taken in the nursery in sparsely sown beds to avoid competition between seedlings. The data suggest that the character is controlled by duplicate factors. But there is a definite departure from the expected ratio of 15 green : 1 yellow in the F_2 's and 3 green : 1 yellow in the back-

cross to Kwang. All the three independent F_2 families were homogeneous for the deficiency (X^2 for heterogeneity/2 df. = 0.1439; $P = 0.90-0.95$). The yellow leaved segregants as well as the Kwang parent were definitely poorer in growth compared to the normals and the deficiency of the recessive class was more accentuated with advance in the age of the seedlings after the first four weeks. The growth data under field conditions are presented in Table II.

In the early stages (4 weeks after sowing) the mean height of Kwang was less than half of the normal seedlings, while the leaf number was nearly 1½ times that in Chatham. Therefore it appears that the over-production of leaves compared to its slow growth and inhibition in leaf size are to some extent responsible for its lethality. The difference in height continued even for eight weeks after sowing. However, the normal segregants had greater number of leaves than the yellow segregants by this time. The behaviour of the Kwang parent and yellow-leaved segregants was parallel in all the stages.

To examine whether gametic or zygotic lethality was operating to cause the observed deficiency, F_2 progenies were raised in petri-dishes at a controlled temperature of 70-72° F. Clear segregation was obtained into 236 green : 15 yellow which established that gametic lethality was not involved. Pollen abortion or meiotic abnormalities followed by seed abortion were not detected either in Kwang or in the F_1 . Germination tests were conducted at 70-72° F. and 80-82° F. to find out the stage at which lethality sets in. The results showed that Kwang lags behind Chatham in germination by at least 14 hours with just 4% to 20% germinating on the first day as compared to over 90% in Chatham. In the F_2 , nearly 20% of the seeds lagged behind by 2 days in germination, compared to the rest.

Anatomical studies of the leaf showed that the number of layers of palisade were the same in both yellow and normal. However, the chloroplasts were larger and fewer in Kwang.

The occurrence of types with yellowish green leaves in *Nicotiana tabacum* and *Nicotiana rustica* with sufficient viability to reach production is known in natural and introduced populations of *N. tabacum*.^{4, 5, 6, 8, 10} The variety Kwang is semi-dwarf with early flowering (42 days) compared to 85-90 days to flower in Chatham. The data indicate that the deficiency of the segregating populations was due to (a) slow germination and poor initial growth of yellow seedlings and (b) chlorophyll deficiency which

TABLE I
Segregation for yellow leaf in the F_2 and back-crosses of Chatham \times Kwang

Generation	Green	Yellow	Expected yellows	χ^2	P	Deficiency of recessives
Chatham \times Kwang						
F_2 family (15 green : 1 yellow) 1	1375	73	90.5	3.6095	0.05 - 0.10	19.3%
" 2	1623	83	106.6	5.5731	0.01 - 0.02	22.1%
" 3	2168	109	142.5	8.4004	0.001 - 0.01	22.9%
Chatham $\times F_1$	1410	0	0
Kwang $\times F_1$ (3 green : 1 yellow)	392	85	121.8	14.8247	<0.001	30.2%

TABLE II
Growth data of yellow and green segregants four (A) and eight (B) weeks after sowing in the cross Chatham \times Kwang

Material	A (4 weeks after sowing)			Material	B (8 weeks after sowing)		
	Height in cm.	No. of leaves	Area of the largest leaf in sq. mm.		Height in cm.	No. of leaves	Area of the largest leaf in sq. cm.
Chatham	2.98 \pm 2.00	4.80 \pm 1.61	94.25	Chatham	9.30 \pm 1.04	4.30 \pm 0.26	132.15 \pm 20.56
Kwang	1.16 \pm 0.13	7.60 \pm 0.16	38.25	Kwang	2.60 \pm 0.19	5.30 \pm 0.21	40.48 \pm 3.82
†				F_1 Chatham \times Kwang	11.45 \pm 1.15	4.20 \pm 0.25	85.70 \pm 12.32
F_2 Chatham \times Kwang	2.58 \pm 0.37	4.60 \pm 0.16	74.25	F_2 Chatham \times Kwang			
				Green	8.90 \pm 0.99	6.30 \pm 0.42	165.59 \pm 30.99
				Yellow	4.86 \pm 0.57	4.60 \pm 0.27	47.19 \pm 4.00
Kwang $\times F_1$ †	2.29 \pm 0.39	6.50 \pm 0.27	91.00	Kwang $\times F_1$			
				Green	10.68 \pm 1.32	6.70 \pm 0.30	165.64 \pm 21.22
				Yellow	3.95 \pm 0.71	6.20 \pm 0.51	70.46 \pm 17.58
Chatham $\times F_1$	2.79 \pm 0.45	5.00 \pm 0.37	100.32	Chatham $\times F_1$	9.15 \pm 0.70	5.10 \pm 0.38	118.41 \pm 16.49

F_1 data not available.

† Green vs. yellow segregants were not clearly distinguishable at this stage.

sets in about four weeks after sowing in the yellow segregants, at a time when the normal seedlings commence shooting up in growth.

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