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COLOUR OF FLORAL PARTS IN *NICOTIANA RUSTICA*

H. S. POONI and J. L. JINKS

Department of Genetics, University of Birmingham, Birmingham B15 2TT

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1. Introduction

This note records the cumulative information on the genetical control of the colour of floral parts in *Nicotiana rustica* and the genotypes of the more widely grown varieties in respect of the controlling loci.

Nicotiana rustica is an allopolyploid with $2n = 4x = 48$ chromosomes which has originated from intercrossing of two diploid species *Nicotiana paniculata* ($2n = 2x = 24$) and *Nicotiana undulata* ($2n = 2x = 24$). The chromosome complements from both of these species are represented in full in the new species and there is little evidence of any significant genetic loss during speciation (Goodspeed, 1954). We would expect therefore that the genes controlling floral and ovary colour for either of these diploids should also be duplicated in the allotetraploid.

Previous evidence shows that the presence (black) and absence of anthocyanin in the floral parts is under the control of two alleles (A, a) at a single locus with presence dominant to absence (Mather and Vines, 1952). Yellow vs. non-yellow (black or green) floral parts, however, segregate with the frequencies expected if controlled by two unlinked loci with non-yellow displaying dominant epistasis to yellow which is the multiple recessive phenotype (Jinks, 1954). At one or both loci we could, therefore, have three alleles A, a and y. On the assumption that all three alleles can occur at each of the two loci, nine possible homozygous genotypes can be expected among the three phenotypes, black, green and yellow which are most clearly expressed in the immature ovary.

Number	Genotype	Ovary colour
1	$A_1A_1A_2A_2$	Black
2	$A_1A_1a_2a_2$	
3	$a_1a_1A_2A_2$	
4	$A_1A_1y_2y_2$	
5	$y_1y_1A_2A_2$	
6	$a_1a_1a_2a_2$	Green
7	$a_1a_1y_2y_2$	
8	$y_1y_1a_2a_2$	
9	$y_1y_1y_2y_2$	Yellow

On the basis of the parental and F_1 phenotypes and the segregations in the F_2, BC_1 and BC_2 families of all possible pairwise crosses among these nine homozygotes we can generate expectations which will allow us to test this explanation of the genetical control of floral phenotype and classify the most widely used varieties of *Nicotiana rustica* in respect of these loci. The expected segregation ratios are tabulated in table 1.

TABLE 1

Expected segregation ratios in the F_1, F_2 and first backcross generations (BC_1 and BC_2) of the pairwise crosses between all nine possible homozygotes in respect of two loci with three alleles per locus

Classification	Cross	Generations F_1 B:G:Y*	F_2 B:G:Y	BC_1 B:G:Y	BC_2 B:G:Y
		(a) *Black × Black crosses*			
1	1×1, 1×2, 1×3, 1×4, 1×5, 2×2, 2×4, 3×3, 3×5, 4×4, 5×5	All black	All black	All black	All black
2	2×3, 3×4	All black	15:1:0	All black	3:1:0
3	2×5	All black	15:1:0	All black	All black
4	4×5	All black	15:0:1	All black	All black
		(b) *Black × Green crosses*			
1	1×6, 1×7, 1×8	All black	15:1:0	All black	3:1:0
2	2×6, 2×7, 2×8, 3×6, 3×7, 3×8, 4×6, 4×7, 5×6, 5×8	All black	3:1:0	All black	1:1:0
3	4×8, 5×7	All black	12:3:1	All black	1:1:0
		(c) *Black × Yellow crosses*			
1	1×9	All black	15:0:1	All black	3:0:1
2	2×9, 3×9	All black	12:3:1	All black	2:1:1
3	4×9, 5×9	All black	3:0:1	All black	1:0:1
		(d) *Green × Green crosses*			
1	6×6, 6×7, 6×8, 7×7, 8×8	All Green	All Green	All Green	All Green
2	7×8	All Green	0:15:1	All Green	All Green
		(e) *Green × Yellow crosses*			
1	6×9	All Green	0:15:1	All Green	0:3:1
2	7×9, 8×9	All Green	0:3:1	All Green	0:1:1
		(f) *Yellow × Yellow crosses*			
1	9×9	All Yellow	All Yellow	All Yellow	All Yellow

* B = Black, G = Green, Y = Yellow

2. RESULTS

Unpublished data from many sources, for example, the breeding programmes of Jinks (1954) and Virk (1976) and others are summarised in table 2. Where data from independent crosses are homogeneous they have been pooled, which reduces them to seven sets. Each set fits only one of the expectations given in table 1. The two locus, triallelic model, therefore, accounts for the observed data and the genotypes of the varieties on this model are given in table 3. Among these only four of the nine possible homozygotes are represented and they require that the *a* and *y* alleles occur at both loci and the *A* allele at one of them.

TABLE 2

Proportions of Black: Green: Yellow ovaried plants in the basic generations of various crosses

Crosses: Parental phenotypes		Crosses: Parental varieties	Generations: F_1	F_2	BC_1	BC_2
Black × Black	(a) 1*	$V_1 \times V_{12}$	8:0:0	80:0:0	80:0:0	79:0:0
Black × Green	(b) 2	$V_{12} \times (V_2, V_5, V_7, V_{29}$ and $V_{38})$	297:0:0	302:93:0	198:0:0	72:87:0
Black × Yellow	(c) 2	$V_{12} \times (V_{14}$ and $V_{41})$	118:0:0	102:43:5	80:0:0	21:37:8
Green × Green	(d) 1	Pairwise crosses between V_2, V_5, V_7, V_{29} and V_{38}	0:596:0	0:749:0	0:396:0	0:396:0
Green × Yellow	(e) 1	$(V_2, V_5, V_{29}$ and $V_{38}) \times (V_{14}$ and $V_{41})$ and $V_{22} \times (V_{14}, V_{27}, V_{34}, V_{72}, V_{73}$ and $V_{80})$	0:788:0	0:1466:91	0:1019:0	0:757:272
Green × Yellow	(e) 2	$V_7 \times (V_{14}$ and $V_{41})$	0:118:0	0:116:44	0:80:0	0:35:35
Yellow × Yellow	(f) 1	$V_{14} \times V_{41}$	0:0:60	0:0:78	0:0:40	0:0:40

* See table 1.

TABLE 3

Genotypes of varieties of Nicotiana rustica *in respect of the two loci controlling ovary colur*

Variety	Ovary Phenotype	Genotype
V_1	Black	$A_1A_1a_2a_2$ (or $a_1a_1A_2A_2$)*
V_2	Green	$a_1a_1a_2a_2$
V_5	Green	$a_1a_1a_2a_2$
V_7	Green	$a_1a_1y_2y_2$ (or $y_1y_1a_2a_2$)
V_{12}	Black	$A_1A_1a_2a_2$ (or $a_1a_1A_2A_2$)*
V_{14}	Yellow	$y_1y_1y_2y_2$
V_{22}	Green	$a_1a_1a_2a_2$
V_{27}	Yellow	$y_1y_1y_2y_2$
V_{29}	Green	$a_1a_1a_2a_2$
V_{34}	Yellow	$y_1y_1y_2y_2$
V_{38}	Green	$a_1a_1a_2a_2$
V_{41}	Yellow	$y_1y_1y_2y_2$
V_{72}	Yellow	$y_1y_1y_2y_2$
V_{73}	Yellow	$y_1y_1y_2y_2$
V_{80}	Yellow	$y_1y_1y_2y_2$

Varieties V_1 and V_{12} are identical genotypes. So either they are both $A_1A_1a_2a_2$ or $a_1a_1A_2A_2$.

3. References

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