

AN ASSOCIATION BETWEEN THE PRESENCE OR ABSENCE OF BASAL STEM ANTHOCYANIN AND ALLELES AT THE D LOCUS IN PISUM

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The preceding article provides background information about PI 356980 in relation to its use in studies of basal stem anthocyanin. Although this accession was found to contain plants with, and plants without, basal stem anthocyanin (PNL 9:42-45, 1977; PNL 10:63, 1978; PNL 10:64-65, 1978), any conclusions drawn from studies of this accession are bound to be ambiguous until the genetic situation is clarified. Accordingly, reciprocal crosses were made at Geneva using plants of four sublines of PI 356980 provided by C. Nozzolillo and designated by her as 2-4, 2-8, 5-18, and 10-5. Sublines 2-4 and 2-8 were lines with, whereas 5-18 and 10-5 were lines without, basal stem anthocyanin. The field-grown F₁ plants from these crosses produced some 3500 seeds, approximately 1400 of which were retained in Geneva and 2200 of which were forwarded to Ottawa (where not all have been analyzed).

When remnant selfed seeds from plants of these four second-generation (G₂) lines were planted, line 2-4 was found to produce plants with and plants without basal anthocyanin whereas 2-8 produced plants exclusively with and 5-18 and 10-5 produced plants exclusively without basal anthocyanin. Since the seeds in each instance derived from individual selfed plants, line 2-4 was clearly heterozygous for a gene(s) controlling the presence or absence of basal stem anthocyanin. Significantly, moreover, the plants of this line which showed red stems also expressed the "w" allele at D locus whereas the plants without basal anthocyanin (green stems) manifested the "co" allele at the same locus. Although the field-grown F₁ plants from the crosses involving 2-4 (D^{*}) and the other sublines (all D^{°°}) were not scored for basal anthocyanin, they were scored for D^{*} and D^{°°}. Eighteen were classified as D^{*} and 11 as D^{°°}, clearly showing that at least some of 2-4 plants used as parents were heterozygous D^{*}/D^{°°} (D^{*} is known to be dominant to D^{°°}).

In the F₂ of crosses involving 2-4 plants as one parent, progenies from the 11 F₁ plants which were D^{°°} were exclusively green-stemmed (Table 1). In contrast, the 18 F₁ plants scored as D^{*} produced progenies segregating both for D^{*} - D^{°°} and for the red and green stem. In these populations all 722 (151 at Geneva and 371 at Ottawa) of the F₁ plants with D^{*} exhibited basal stem anthocyanin whereas all 243 (117 at Geneva, 126 at Ottawa) of the F₂ plants with D^{°°} were without stem anthocyanin. Scoring was easy and clear except for two plants which showed so little pigment as to be questionable. Progeny tests of these two plants showed them to be heterozygous for D^{*}/D^{°°}, the D^{*} segregants being unmistakably red stemmed, and the D^{°°} segregants being green stemmed. Thus, without exception, the D^{*} allele in this line was found to be associated with red stems whereas the D^{°°} allele was associated with green stems. The combined total of 965 plants (468 observed at Geneva and 497 at Ottawa) is large enough to suggest pleiotropy rather than tight linkage but even more plants would be desired.

Bearing on the question of linkage vs pleiotropy are observations of subline 2-8 and progeny from crosses with it. This subline, like 2-4, shows basal stem anthocyanin but, unlike 2-4, it is D^{°°} rather than D^{*}. F₂'s of crosses between 2-8 and either 5-18 or 10-5 (both green stemmed)

showed a clear 3:1 ratio of red vs green stems but without segregation for alleles at the D locus since all are D^{oo}. Obviously, therefore, red stems can occur in association with D^{oo}, suggesting that the association found in subline 2-4 may be an expression of linkage rather than pleiotropy. But this cannot yet be accepted as fact since it is also possible that the basal anthocyanin in sublines 2-4 and 2-8 is determined by entirely different genes.

The cross 2-8 and 2-4 is especially noteworthy in light of the fact that both lines have red stems but 2-8 is D^{oo} and 2-4 is D^{*}. Since, however, the F₁ was D^{oo} and the F₂ showed a 3 red : 1 green ratio without segregation for "w" or "co" at the D locus, we can only conclude that the 2-4 parental plant was heterozygous and that in the only F₁ seed obtained, we were unlucky enough to draw the gamete containing D^{oo} (and also green stem). Thus, this cross bears repeating.

These results confirm and expand the findings presented in the previous article by showing that at least one type of stem pigmentation is under monogenic control and by showing a close association between basal stem pigmentation and the "w" allele of the D locus. It would appear, therefore, that a concrete beginning has been made with respect to the genetic control of stem pigmentation in peas. The type of expression reported here is clear in the seedling stems immediately upon emergence from the growing medium; later the pigmentation tends to fade. It is recognized that this may be only a small part of a larger story since different types and expressions of stem pigmentation have been encountered by us and by others.

Table 1. Results of various crosses among four sub-lines of PI 356980. Field-grown F₁'s were scored for the "w" and "co" alleles of the D locus, but the F₂ populations were scored for presence (red stem) or absence (green stem) of basal stem anthocyanin as well as for the "w" and "co" of the D locus. Numbers in () were obtained in Ottawa from observations made on seed that came from the corresponding packets used at Geneva.

Entry	Parents	F ₁	Segregation in F ₂										
			Red stems		Green stems		Red stems		Green stems				
			D ^w	D ^{co}	D ^w	D ^{co}	D ^w	D ^{co}	D ^w	D ^{co}			
C278-52	2-4 x 5-18	D ^w	48(46)	0	0	15(21)							
53	(Red D ^w x Green D ^{co})	D ^w	25(26)	0	0	5(14)							
54		D ^w	2	0	0	2							
55		D ^w	25(40)	0	0	9(9)							
56		D ^w	3(16)	0	0	0(8)							
57		D ^w	17(42)	0	0	10(6)							
58		D ^{co}						0	0	0	7		
59		D ^{co}						0	0	0	36		
60		D ^{co}						0	0	0	15		
61		D ^{co}						0	0	0	44		
62		D ^{co}						0	0	0	35		
63	5-18 x 2-4	D ^{co}						0	0	0	18(20)		
64	2-4 x 10-5	D ^w	22(58)	0	0	5(15)							
65	(Red D ^w x Green D ^{co})	D ^w	27(41)	0	0	13(19)							
66		D ^w	12	0	0	5							
67		D ^w	34	0	0	11							
68		D ^w	15	0	0	6							
69		D ^w	17	0	0	6							
70		D ^w	7	0	0	3							
71		D ^w	18	0	0	1							
73	10-5 x 2-4	D ^w	28(38)	0	0	10(12)							
75		D ^w	29(43)	0	0	8(17)							
77		D ^w	7(21)	0	0	5(5)							
82		D ^w	15	0	0	5							
72		D ^{co}						0	0	0	19(25)		
74		D ^{co}						0	0	0	11(20)		
76		D ^{co}						0	1	0	18		
78		D ^{co}						0	0	0	12		
79		D ^{co}						0	0	0	26		
80		D ^{co}						0	0	0	47		
81		D ^{co}						0	0	0	30		
83		D ^{co}						0	0	0	10		
88	2-8 x 2-4 (Red D ^{co} x Red D ^w)	D ^{co}	0	65(99)	0	27(47)							
89	5-18 x 2-8	D ^{co}	0	30	0	13							
90	(Green D ^{co} x Red D ^{co})	D ^{co}	0	24	0	6							
91		D ^{co}	0	38	0	16							
92	2-8 x 5-18	D ^{co}	0	6	0	4							
93		D ^{co}	0	18	0	6							
94	10-5 x 2-8	D ^{co}	0	35	0	15							
95	(Green D ^{co} x Red D ^{co})	D ^{co}	0	10	0	5							
96		D ^{co}	0	67	0	23							
97		D ^{co}	0	24	0	6							
98		D ^{co}	0	17	0	3							
99	2-8 x 10-5	D ^{co}	0	30	0	16							
100		D ^{co}	0	29	0	8							
101		D ^{co}	0	22	0	6							
102		D ^{co}	0	19	0	8							
84	10-5 x 5-18	D ^{co}						0	0	0	45		
85	(Green D ^{co} x Green D ^{co})	D ^{co}						0	0	0	30		
86		D ^{co}						0	0	0	28		
87		D ^{co}						0	0	0	11		