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THE COSTATA MUTANT IN THE PEA CAUSED BY MUTATION IN THE LOCA lum-1, lum-2, lum-3, lum-4, and lum-5.

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Abstract

The costata mutant in the pea is characterized by green veins and yellowish green interveinal areas. Eleven cases of induced mutation have been reported and possibly one spontaneous. Eight of these induced cases was found to be due to mutation in the newly assigned gene lum – 2, type-line assigned 5160, one to mutation in a previously investigated gene lum, here reassigned lum – 1. Three mutants were found to be due to mutation in three different loca, different also from lum – 1 and lum – 2. These were assigned the symbols lum – 3, type-line 5443, lum – 4, type-line 5609, and lum – 5, type-line 5937. Two further mutants probably belong to two further different loca but gene symbolization is pending further investigations.

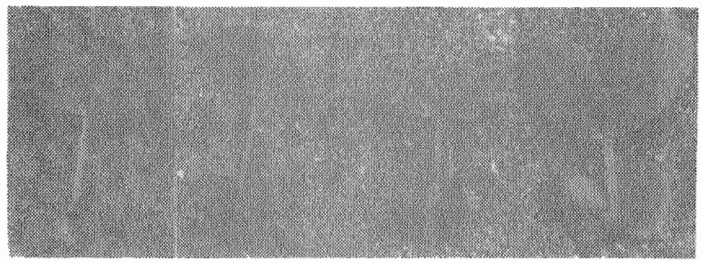
Introduction

In a previous paper (Arain, 1985) 6 different costata mutants in the pea were investigated as to possible allelism. The results indicated that several genes could give rise to the costata phenotype. Sidorova (1981) investigated four mutants, and reported all to be allelic. Monti (1970) reported one mutant and the mutant locus to be located in chromosome 4. Eleven different costata mutants are now available including Monti's and Sidorova's mutants. It seemed therefore worthwhile to investigate all available costata mutants in order to clarify the number of loca involved.

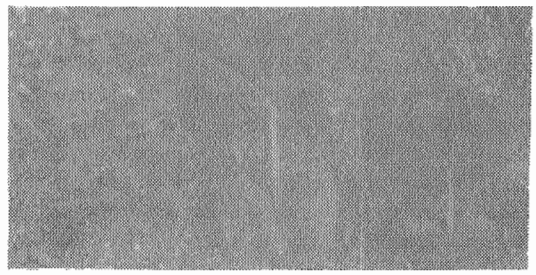
Material and Method

The first reported case of a costata mutation was probably the spontaneous one described by Kellenberger (1952). Since then, a number of induced mutations of this type has been reported.

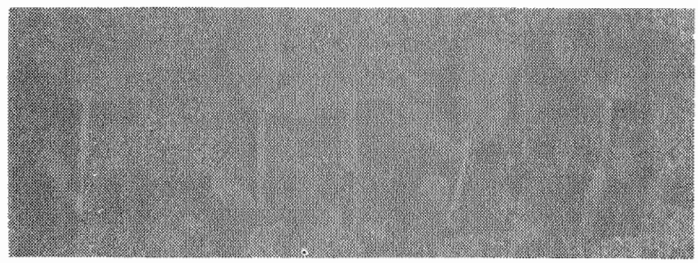
Blixt (1972) reported 3 cases which were obtained from 1958 through 1960 after X-ray treatment of the cultivar Parvus, and has been maintained as lines 5443, 5609 and 5271. Three further cases were obtained in the year 1961 after El-treatment of the cultivar Weitor. Presently preserved are lines 5120, and 5366, as one of these mutants, line 5161, was lost after some years. In 1962 one case was obtained after treatment of the cultivar Weitor with EMS and is now maintained as line 5818. Two further cases, obtained after EMS-treatment of the cultivar Parvus, are maintained as line 5937 and line 5958.



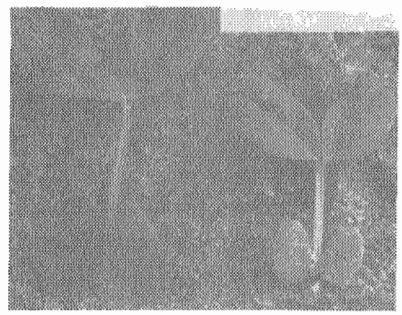
1107 5271 5443 5609



5934 5958 6011



1263 5160 5366 5818



2157 5870

Fig. 1. Ten costata mutants with lines of origin. First and second row: line 1107 (cultivar Parvus) with its mutants 5271, 5443, 5609, 5937, 5958 and Monti's mutant lum, 6011. Third row: line 1263 (cultivar Weitor) with its mutants 5160, 5336 and 5818. Fourth row: line 2157 (cultivar Torsdag) and Sidorova's mutant, 5870.

Monti (1970) reported one mutant after diethylsulphate- treatment of the cultivar Parvus. The mutant was named luteo maculata and the gene responsible located to chromosome 4 and assigned the gene symbol lum. The lum line is here maintained as line 6011.

Sidorova (1970) reported four costata mutants after treatments with EMS, NUM or gamma-rays of the cultivar Torsdag. All were found to be allelic. One of these is maintained here as line 5870.

The ten mutants maintained at Weibullsholm Plant Breeding Institute in the Nordic Gene Bank Pea Collection are shown in Figure 1. The phenotypic expression is quite characteristic, at the first sight reminding of a virus-mottling, with the veins of a rather dark green and the interveinal areas of a yellowish green colour. The expression is varying slightly with temperature and light intensity but for most mutants clearly discernible. Most variation in expression is exhibited by mutants 5271 and 5443. The narrow leaflet-shape in line 5937 might or might not be due to a separate mutation.

Results and Discussion

In a previous paper (Arain, 1985), investigation of 6 costata mutants indicated that all such mutants may not be allelic. The result of further crosses, involving 11 costata mutants and their origin lines have therefore been analysed.

The costata mutant is occurring rarely but regularly. Genetic work has previously been carried out by Monti (1970) and Sidorova (1981). Monti designated his mutant luteomaculata and described it as having chlorina interveinal areas detectable on all the leaves. The mutant seemed fully fertile. In an F_2 population of about 500 plants, 19.64 per cent showed the mutant type. This corresponds to a Chisqr for 3:1 of about 7.8, i.e., a significant deficit of mutants of the same order of magnitude as found in this investigation. Since the character was detectable at the seedling stage, the linkage analysis carried out by Monti was limited to the genes r, i, le, tl and wb. A recombination value of 12.02 +– 4.6 per cent was found with le on chromosome 4. It was pointed out that the distinct phenotype and the good fertility makes this mutation useful as a seedling marker for linkage studies in chromosome 4. Sidorova (1981) found that her four mutants were all allelic. She does not report, however, whether or not they are allelic with lum.

The data obtained through Origin Test crosses are presented in Table 1 and the data from the Identity Test crosses in Table 2. It should first be noted that line 5161 is no longer available but that early crosses, particularly cross 2976, showed it allelic to line 5160. Regarding the origin crosses as given in Table 2, it might be noted that

Table 1. Origin test crosses (ORX)

Cross number	Parents	F_1 phenotype	F_2-segregation fertility	normal	mutant	Chisqr 3 : 1
5571 1)	5366 x 1263	Normal	89.5	1027	265	13.89***
5269	5443 x 1107	Normal	86.4	819	251	1.44NS
6298	5609 x 1107	Normal	47.4	564	149	6.29**
6300	5818 x 1263	Normal	2)			
6301	5870 x 2157	Normal	66.6	282	58	11.43***
5683 1)	5937 x 1107	Normal	75.5	135	41	0.27NS
5645	5958 x 1107	Normal	98.0	960	225	22.85***
6258	6011 x 1107	Normal	59.2	103	23	2.73NS
5657	6011 x 1107	Normal	88.8	351	123	0.23NS
6258+5667			77.6	454	146	0.14NS

1) Previously published (ARAIN, 1985)

2) F_2 not yet analysed.

the results from a cross 5160 x 1263 (Weitor) and 5271 x 1107 are not at present available. With regard to line 5160 it is found from the IDX-crosses, presented below, to be allelic with the mutants represented by lines 5870 and 5958. These show in the ORX-crosses 6301 and 5645, respectively, a large deficit of recessive mutants, not much larger, however, than that found by Monti (1970) in the case of lum. In addition, data from an F_2-generation of the IDX-cross 4576 (5160 x 6011) segregated in two mutant types, i.e., 809 normal plants to 137 lum-phenotypes to 318 plants similar to line 5160. Similarly, an F_2 of the IDX-cross 4583 (lines 5958 x 6011) segregated 736 normal to 245 lum-like to 287 line 5958-like plants. Together, these data are clearly in support of regarding the mutant represented by the lines 5160, 5870 and 5958 as monogenic recessive mutants. With regard to line 5271, such conclusive data are not available, as is also the case for line 5818.

The mutants represented by the lines 5443, 5609 and 5937 show no to moderate deficit of recessives and may without further discussion be regarded as monogenic recessive mutants on the basis of the data as presented. Against the background of experienced deficits of recessives in induced mutants that despite much higher deficits still have shown all characteristics of monogenic recessive mutants, also line 5366 can be regarded as such.

The results of the identity test crosses are presented in Table 2. The results indicate that lines 5160, 5161, 5366, 5870 and 5958 are mutated at the same locus. That means that Sidorova's four mutants, induced by EMS, NUM and gamma-rays, are allelic to four of Blixt's mutants, obtained after treatment with EI or EMS. These eight costata -mutants, further, are due to mutation in a locus different from lum in chromosome 4.

Table 2. Identity test crosses (IDX)

Cross number	Parents	F_1 phenotype	No of F_1 plants
2976 1)	5160 x 5161	costata	3
6260	5160 x 5271	Normal	9
2977 1)	5160 x 5366	costata	1
2979	5160 x 5443	Normal	5
2981	5160 x 5609	Normal	18
6261	5160 x 5818	Normal	7
6262	5160 x 5870	costata	4
6259 1)	5160 x 5937	Normal	5
4576 1)	5160 x 6011	Normal	6
6271	5271 x 5366	Normal	14
6288	5271 x 5443	Normal	4
6290	5271 x 5818	Normal	12
6291	5271 x 5870	Normal	9
6278	5271 x 5937	Normal	3
6283	5271 x 5958	Normal	5
6255	5271 x 6011	Normal	4
6272	5366 x 5443	Normal	4
6273	5366 x 5609	Normal	5
6274	5366 x 5818	Normal	7
6275	5366 x 5870	costata	6
6270 1)	5366 x 5958	?	10
6253 1)	5366 x 6011	Normal	10
6292	5443 x 5609	Normal	2
6293	5443 x 5818	Normal	4
6294	5443 x 5870	Normal	12
6279	5443 x 5937	Normal	5
6284	5443 x 5958	Normal	1
4580	5443 x 6011	Normal	8
6296	5609 x 5818	Normal	5
6297	5609 x 5870	Normal	5
6280	5609 x 5937	Normal	1
6285	5609 x 5958	Normal	7
4581	5609 x 6011	Normal	18
6299	5818 x 5870	Normal	9
6281	5818 x 5937	Normal	2
6286	5818 x 5958	Normal	6
6256	5818 x 6011	Normal	2
6282	5870 x 5937	Normal	13
6287	5870 x 5958	costata	14
6277 1)	5937 x 5958	Normal	3
6254 1)	5937 x 6011	Normal	3
4583 1)	5958 x 6011	Normal	11

1) Previously published (Arain, 1985).

Gene Symbol	Line number	IDX Line number 55555 11389 66675 01608	55555 24689 74013 13987	ORX 112 121 065 737
lum–1	6011	NNNNN	NNNNN	N
lum–2	5160	m m m	NNNNN	
lum–2	5366	m?	NNNN	N
lum–2	5870	m	NNNNN	N
lum–2	5958		NNNNN	N
	5271		N NN	
lum–3	5443		NNN	N
lum–4	5609		NN	N
	5818		N	N
lum–5	5937			N

Fig. 2. Summary of IDX and ORX crosses with proposed gene symbols. N indicates Normal, m mutant F1-phenotype.

In accordance with the recommendations of the Pisum Genetics Association (Anon., 1977) this locus, typified by line 5160, may be given the gene symbol lum – 2, Monti's lum automatically becoming lum – 1.

From the data presently available it seems also clear that the mutants represented by the lines 5443, 5609 and 5937 have undergone mutation at different loca, loca which are also identical neither with lum – 1 nor with lum – 2. The symbol lum – 3 is therefore given to the muatant represented by line 5443, with this line as type-line. Line 5609 will similarly be type-line for the new assigned symbol lum – 4, and line 5937 for the new assigned symbol lum – 5. Since sufficient data are at this moment not available for the mutants represented by the lines 5271 and 5818, these are not here symbolised, pending further investigation.

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