

Further observations on the expression of *lobed standard* (*lst*) and *keeled wings* (*k*) and their involvement in petal identity

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A variant arising from cv. Alaska (UKPCC 69065, registered as JI 3021) was reported as having lobes on the standard petal (2). This mutation has been tentatively designated *lobed standard* (*lst*). The mutation was reported to behave as a single mendelian recessive gene. Variability in expression was observed in the degree of lobing both between plants and sowings. Expression was variable in glasshouse grown plants, and variation was also observed with season of sowing. There was consistent but less marked expression of lobing in field grown samples.

In an effort to map the mutation, JI 3021 was crossed with JI 15 (*A,b,gp,Tl,D^{co},Le,R,ce,K,Wb,S*) and JI 73 (*a,B,gp,tl,d,le,r,Ce,k,wb,s*). F₂ populations were sown under glass in mid August and received no supplementary lighting throughout their growth. The lobed standard phenotype was scored as a single recessive gene in both populations (Table 1). No linkage to any of the phenotypic markers in either cross was observed.

Table 1. Monohybrid segregation for *lst* in 2 F₂ populations

	Normal standard	Lobed standard	Total	X
JI3021 x JI15	93	26	119	0.63
JI3021 x JI73	79	35	106	3.63

The variation in phenotypic expression was documented throughout the flowering period. Recordings were aided by the use of horizontal and vertical bisectors dividing the standard into quadrants (Fig. 1). The following expressions were observed in the standard petal.

- i. Absence of the apical notch giving a very rounded appearance.
- ii. Slight curves in the outer edge providing a slight hint of lobing.
- iii. Size of lower lobes varied from half the size of the top lobe to short spurs.
- iv. Partial formation where only *one* half of a standard forms (longitudinal split). (Quadrants 1a and b or 2a and b)
- v. Only the top halves of some sides of standards developed. (Quadrants 1a and/or 2a.)
- vi. Complete absence of standard.

The presence of any one of the above characteristics at the first flowering node was confirmed by deviation from the normal standard structure at later flowering. The effects were strongest and most consistent in flowers at later nodes.



Fig. 1. Variation in expression of *lst* in the shape of the standard petal. Inset lines show standard quadrants.

Individuals that were scored as *lst* which were also pigmented (A or Aa) were abnormal in both level and distribution of pigmentation. The following observations were noted.

- i. Strong flecking of regions of the standard to an intensity of pigment that matched that of the wings. The flecking was also observed in a paler version in plants that were A/ce.
- ii Flecking was most frequent in quadrants 1a,2a tending mostly towards the vertical.
- iii. In a few cases, the intensity of the whole standard was a deep purple in all quadrants.
- i\). Pigment was consistently stronger at the outer edge of the petal and was occasionally streaky or washed through the main body of the standard.

Abnormal pigmentation was coincident with plants with altered standard shape and thus could be used to confirm the expression of *lst*. In terms of the rest of the flower. A degree of lobing was also noted on the wings of JI 3021 grown in the field. All other parts of the flowers were always found to be normal.

The gene for keeled wings *k* (3) was also segregating in the JI 3021 x JI 73 population. In all plants of *k/k*, *lst/lst*, genotype, it was noted that all petals were extremely small. The standard petal was observed to be of equal length, shape and pigmentation as that of the keel and modified wings but lacked the ridge of the keel. The overall impression of

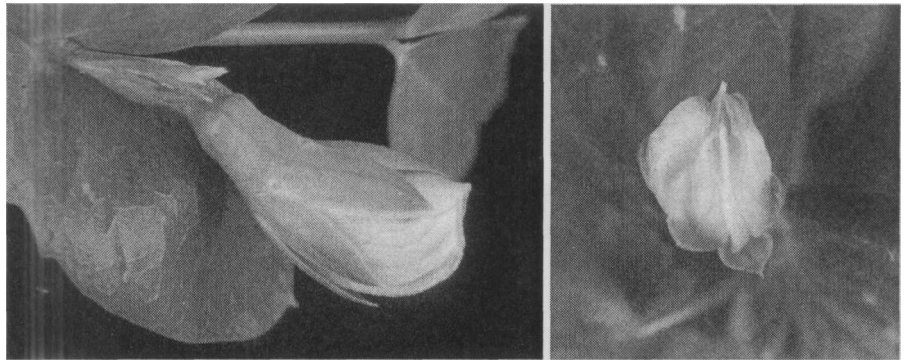


Fig.2.

Keel like standard of *lst/k* mature flowers.

the flower was of never progressing beyond the closed bud stage when in fact the anthers were dehiscent and fertilisation had occurred (Fig. 2).

From observations relating to the interaction between *lst* and A it is clear that the *lst* standard has taken on some of the characteristics of wings in terms of pigment intensity. The pattern of pigmentation and shape suggests the *lst* standard petal can be thought of as a pair of modified wings fused along the central region. In the *lst* mutant, the standard petal is wing-like. In a *k* background, more wings are keel like, so in the *lst k* double mutant, the standard is also keel like. *Lst* is thus required to confer standard identity. The zygomorphy of the pea flower can be interpreted as the action of *k* on the keel like petals converting them to wings, and of *lst* on a wing like petal converting it to a standard. Both *lst* and *k* are required in the formation the characteristic zygomorphic flower of pea (1).

A line from this population of genotype *lst/lst,k/k* has been registered as JI 3207 in the John Innes Pisum collection and is available for study.

1. Ferrandiz, C, Navarro, C., Gomez, M.D., Canas, L.A. and Beltran, J.P. 1999. Dev. Genet. 25: 280-290.
2. Pellew, C. and Sverdrup, A. 1923. J. Genet. 13: 125431.
3. Winfield, P. 1987. Pisum Newslett. 19: 84.