INTERNODE LENGTH IN PISUM: A FURTHER MUTATION AT THE la LOCUS

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Dwarfing mutants in peas are relatively common (see 9 for review). The genes at seven such loci, na, le, lh, ls, lw, lk, and lm, are well established (6,11). These genes either block steps in the gibberellin biosynthetic pathway prior to the production of the native active gibberellin, GA_1 (e.g. na, le, lh, ls, see 3,5) or reduce the response produced by a certain level of GA_1 (e.g. lk, lw, see 6,10). However, relatively few mutants with increased internode length have been described. The best examined are the crypto and slender types produced by the duplicate gene combinations la cry^c (8,11) and la cry^s (1,11), respectively. These gene combinations cause the plant to behave as if all the gibberellin mediated responses are either partially (la cry^c) or fully saturated (for la cry^s) even though endogenous gibberellin levels are not markedly altered (2,7). Consequently, it was of considerable interest when Ms. B. Kneen and Dr. T. LaRue of the Boyce Thompson Institute provided a new mutant, R90, derived from cv. 'Sparkle' after gamma radiation which had increased internode length. The present report examines the genetic nature of the mutation and its responsiveness to applied GA_1 and the gibberellin synthesis inhibitor paclobutrazol (PP333).

Cross Sparkle x R90 indicated that the increased internode length of R90 was caused by a single recessive mutation since the F1 was dwarf and the F2 gave a clear 3:1 segregation (X^2 = 1.7) (Fig. 1). Cross R90 x L133 (slender, le la cry^s Na Lh Ls Lk Lw Lm) resulted in F1 plants with elongated internodes rather than the expected dwarf habit (Fig. 1). This indicated that R90 possesses recessive alleles at both the la and cry loci. This was confirmed by cross R90 x L186 (slender, Le la cry^s Na Lh Ls Lk Lw Lm) (Fig. 1). The parental cultivar of R90, Sparkle, possesses the genotype La cry^c since crosses of Sparkle to the le dwarf lines L53L (La cry^s) and L61a (1a Cry) gave, in the F2, either all dwarfs (93 plants) or an 87 dwarf : 4 cryptodwarf segregation (X^2 for 15:1 = 0.54), respectively (Fig. 2). This implies that the mutation in R90 responsible for the increased elongation has occurred at the la locus. The present evidence does not indicate whether this new mutation (which shall be referred to as la$^{(R90)}$) results in exactly the same phenotype as the previously established la allele (1). However R90 (presumed genotype le la$^{(R90)}$ cry^c) is phenotypically identical to cryptodwarf lines (e.g. L8, le la cry^c, Fig. 1).

Data from the application of GA_1 and paclobutrazol (PP333) are consistent with the genetic information. R90 only shows a relatively small promotion of elongation after the application of 10 mkg of GA_1 (40 percent between nodes 5 and 8, Fig. 3) and is only weakly dwarfed by 20 mkg of paclobutrazol (27 percent) compared with the parental dwarf cv. Sparkle (151 and 67 percent, respectively). The inhibition caused by paclobutrazol can be overcome by the application of GA_1 in both lines (Fig. 3).

Cryptodwarf (la cry^{c}) types and particularly the more pronounced slender (la cry^{s}) types have previously been shown to possess reduced responses to treatments (either chemical or genetic) which alter the level of active gibberellin (4,7).

In conclusion, the increased internode length of mutant R90 appears to be caused by a mutation at the la locus (la$^{(R90)}$) which has a similar phenotypic effect to the previously described la allele.

1. De Haan, H. 1927. Genetica 9:481-497.
2. Ingram, T. J. and J. B. Reid. 1987. J. Plant Growth Regulation (in press).
3. Ingram, T. J. and J. B. Reid. 1987. Plant Physiol. 83: in press).
4. Ingram, T. J., J. B. Reid, W. C. Potts, and I. C. Murfet. 1983. Physiol. Plant. 59:607-616.
5. Ingram, T. J., J. B. Reid, I. C. Murfet, P. Gaskin, C. L. Willis, and J. MacMillan. 1984. Planta 160:455-463.
6. Jolly, C. J., J. B. Reid and J. J. Ross. 1987. Physiol. Plant. 69:489-498.
7. Potts, W. C, J. B. Reid and I. C. Murfet. 1985. Physiol. Plant. 63:357-364.
8. Rasmusson, J. 1927. Hereditas 10:1-150.
9. Reid, J. B. 1986. In A Genetic Approach to Plant Biochemistry, pp. 1-34. Eds. A. D. Blonstein and P. J. King, Springer-Verlag, Wien.
10. Reid, J. B. and W. C. Potts. 1986. Physiol. Plant. 66:417-426.
11. Reid, J. B., I. C. Murfet and W. C. Potts. 1983. J. Exp. Bot. 34:349-364.

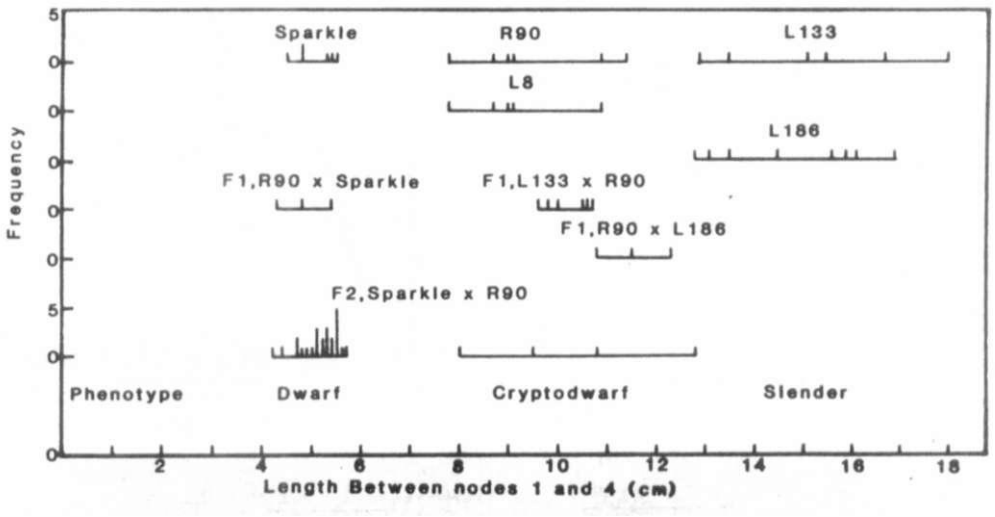

Fig. 1. The distribution of stem length between nodes 1 and 4 for lines Sparkle (le La cry^{c}), R90 (le la cry^{c}), L133 (le la cry^{s}), L8 (le la cry^{c}) and L186 (Le la cry^{s}), the F1 and F2 of cross Sparkle x R90 and the F1 of crosses R90 x L133 and R90 x L186. The plants were grown under an 18 h photoperiod.

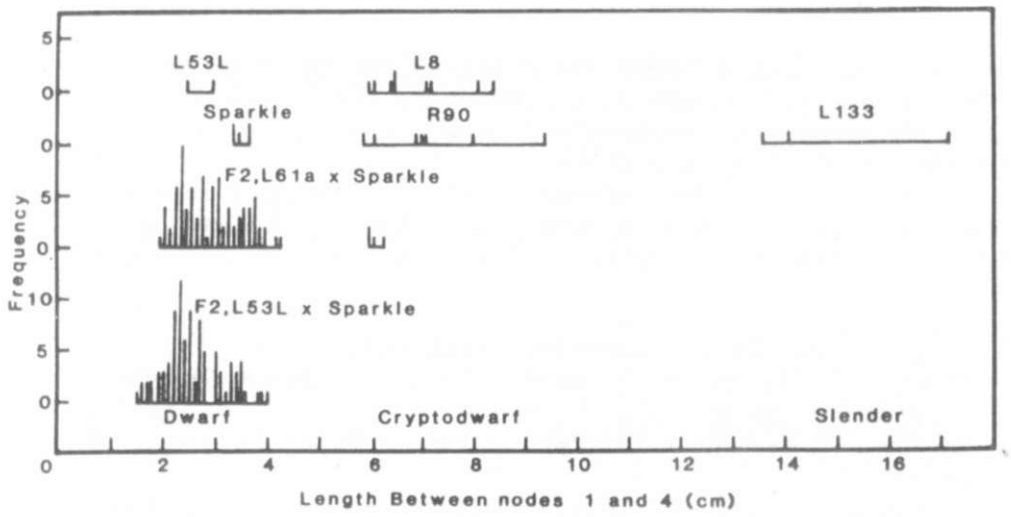

Fig. 2. The distribution of stem length between nodes 1 and 4 for lines Sparkle (le La cry^{c}), L53L (le La cry^{s}), L8 (le la cry^{c}), R90 (le la cryC), L133 (le la cry^{s}) and the F2 of crosses L61a x Sparkle and L53L x Sparkle. Plants were grown simultaneously under an 18 h photoperiod.

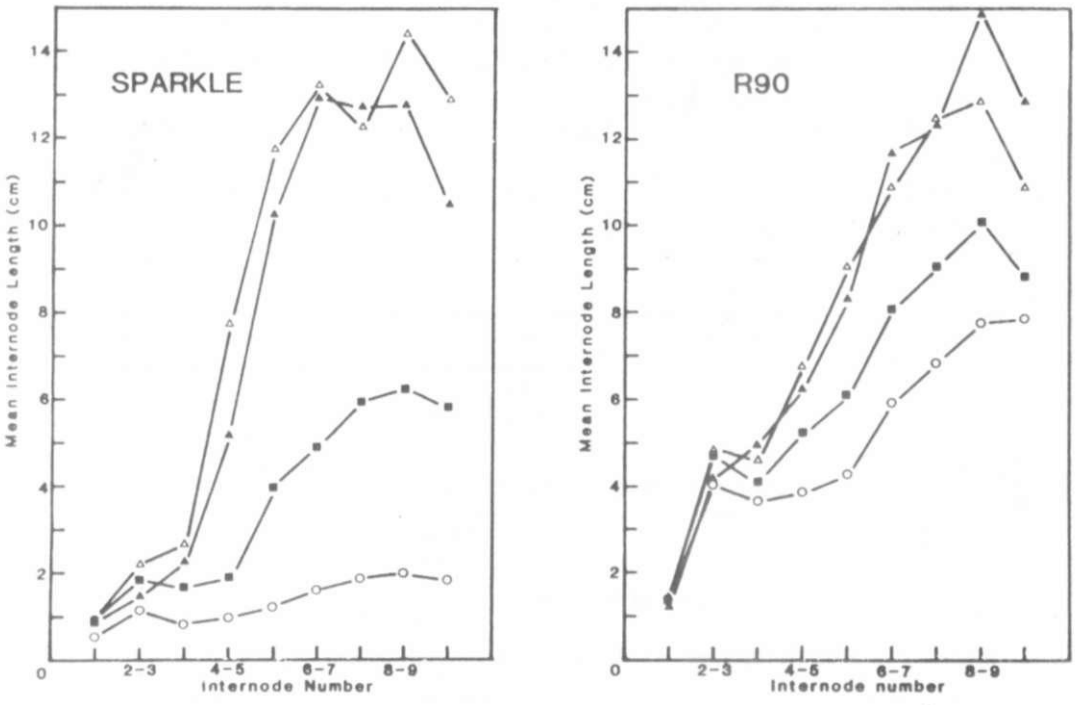

Fig. 3. Internode length plotted against internode number for lines Sparkle (le La cry^{c}) and R90 (le la cry^{c}) treated with either 10 mkg of GA_1 (D), 20 mkg of PP333 (O) or 10 mkg of GA_1 plus 20 mkg of PP333 (•) or left untreated (•). The plants were treated with PP333 on the dry testa in 10 mkl of ethanol before planting and with GA_1 in 5 mkl of ethanol on the last fully expanded leaf 12 days after planting. Plants were grown under an 18 h photoperiod. n >= 8. SE were frequently too small to be indicated on the figure but averaged 0.30 for individual points.

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