Floral initiation in pear trees

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FLORAL INITIATION IN PEAR TREES

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Abstract. - Analysis of several thousand spurs of 'Williams Bon Chrétien' (syn. 'Bartlett') pear showed clearly that leaves promote, whereas fruits - or, more specifically, seeds - inhibit floral initiation in the terminal buds. On spurs with a low leaf number, chlormequat and SADH have a promoting effect on floral initiation, but GA_3 is inhibitory. On long shoots the major factor controlling floral initiation appeared to be the pattern of growth, the relative growth rate of shoots during the month before growth finally ceased being inversely related to the average number of fruit buds per shoot. The results suggest that flower initiation on spurs is controlled mainly by factors acting within each individual spur system.

Introduction. - Many experiments and observations on apple have led to the construction of a proposed model of the flowering process for this species. However, as floral initiation is a developmental phase shared by all higher plants, I believe additional information, leading to an improvement in the model, might be obtained from a study of other fruit species.

This paper deals with the interactions between leaves, fruit and growing shoots in the process of floral initiation in pear. Some recent results on the effects of growth substances are also recorded.

Pear, like apple, bears two sorts of shoots which must be clearly distinguished in any analysis of flower initiation. They are:

Short shoots (spurs or brachyblasts) which grow for 3 to 5 weeks after bud burst, solely by the extension of internodes already formed in the resting bud; and

Long shoots (mesoblasts) in which the shoot apex during growth initiates new internodes and leaf primordia.

Results. -

Short shoots. - Several years' data on several thousand spurs of 'Williams' and 'Passe Crassane' show a good correlation between total leaf area of the spur rosette and the rate of floral initiation in the terminal bud of these spurs. By removing about 90% of the leaf area from spurs at various times between May and September it was shown that, in 'Williams', the apices were unable to initiate flower primordia in response to a floral stimulus from the leaves later than 75 days after full bloom. For 'Passe Crassane' the limit was 120 days after full bloom, which was some days after those fruit buds already formed had entered dormancy.

The effect of leaves on floral initiation varied from year to year, the principal modifying factor being the presence or absence of fruit on the bourse (Figs. 1 and 2). By removal of flowers and fruit at different times we have been able to determine the age of fruit at which this inhibitory

 St Paul, Minnesota and Long Ashton, Bristol - dic. 1973 effect is strongest. It is 30 to 40 days after full bloom, when the diameter is about 15 mm. This fruit removal had no effect on average leaf area.

In apple, Luckwill (1963) and Chan and Cain (1967) have located this inhibitor effect in the seeds. The strong parthenocarpic tendency of 'Williams' has given us the opportunity to confirm this result for pear. The data in Table 1 show clearly the major role of seeds in inhibiting floral initiation. Similar results for 'Williams' and 'Winter Nelis' have recently been obtained by Griggs et al. (1969). It therefore appears that floral initiation in the spurs is controlled by the balance between the promotive effect of the leaves, which is proportional to the total leaf area of the rosette, and the inhibiting influence of the developing seeds, though it is obvious that other factors such as nutrition may modify this balance.

Fig. 3 shows the effect of various growth regulators applied to de-fruited spurs one month after full bloom. The growth retardants SADH and chlormequat were effective in increasing floral initiation, particularly at low leaf areas. CEPA and TIBA also increased floral initiation, but were relatively more effective at higher leaf areas per spur. GA, by contrast, inhibited floral initiation. These results with individual spurs of known leaf area agree with other studies which have been made on whole trees.

Long shoots. - In these shoots flowers can be initiated in terminal and in axillary buds. As far as I know, flowers are never initiated at those nodes formed the previous year which have overwintered in the resting bud, but axillary fruit buds can be produced at nodes formed during the current year, as well as at the shoot apex. Apart from the terminal bud, which is very often floral, the distribution of these fruit buds appears random, bearing no relation to the area of the subtending leaves. So another factor seems to control floral initiation, and this appears to be the growth pattern of the shoot.

The following measurements were made on a large population of long shoots of 'Williams': total growth, growth of internodes and apparent plastochron (by recording the number of leaves each week). The following year we recorded whether the axillary buds were vegetative of floral.

Although the data are not completely analysed, the results presented in Table 2 suggest that, for shoots in any one length class, there is a fairly strong inverse correlation between the average number of fruit buds per shoot and the relative growth rate of the shoot in the month before growth ceases.

Discussion and conclusion. - The main findings from this work on pear are in good agreement with many results obtained on apple trees. They may be summarised as follows:

In short shoots or spurs the results suggest a high degree of self-regulation of the floral initiation process within the bourse system, with the major promoting effect coming from the leaves and the major inhibiting effect from the seeds.

In long shoots apical dominance appears to be a major factor determining the response of the axillary buds to the floral stimulus. Probably floral initiation and differentiation can take place only in apices where a sufficient level of mitotic activity exists. Where apical dominance is strong, mitotic activity - and therefore floral initiation - are suppressed. Conversely, where apical dominance is reduced, the mitotic activity in the lateral buds increases so that their apices become receptive to the floral stimulus.

The experiments with growth substances indicate a direct effect on the short shoots, and probably also on the long shoots, which is connected with leaf efficiency. In addition, these substances can have an indirect effect on flower initiation on long shoots by modifying the general pattern of growth.

Table 1 - The effect of seeds on floral initiation in 'Williams'.

	Tree with seeded fruits	Tree with seedless fruits
Yield (kg)	26.1	26.9
Number of fruits	215	168
Number of seeds/fruit	7.6	0
% floral initiation on spurs with the following leaf area (cm2):		
Less than 30	0	0
(4 leaves) 31 - 50	0	8.6
(5 leaves) 51 - 70	0	27.3
(6 leaves) 71 - 90	0	44.5
Greater than 90	0	87.0

Table 2 - Relative growth rate of long shoots of 'Williams' during the month before growth ceased in relation to number of fruit buds per shoot.

Treatment	Shoot length (cm)	Relative growth rate the month before the growth ceased $\frac{L2 - L1}{L1}$	Average number of fruit buds per shoot
Control	41 - 60	0.17	1.8
		0.05	8.5
	61 - 80	0.41	2.1
		0.15	9.2
	over 80	0.46	2.8
		0.28	10.1
GA_3 50 ppm	61 - 80	0.43	0.0
		0.29	2.0
		0.20	8.4
	over 80	0.34	2.5
		0.33	9.5
Chlormequat 2500 ppm	20 - 40	0.72	2.5
		0.30	6.3
		0.22	11.2

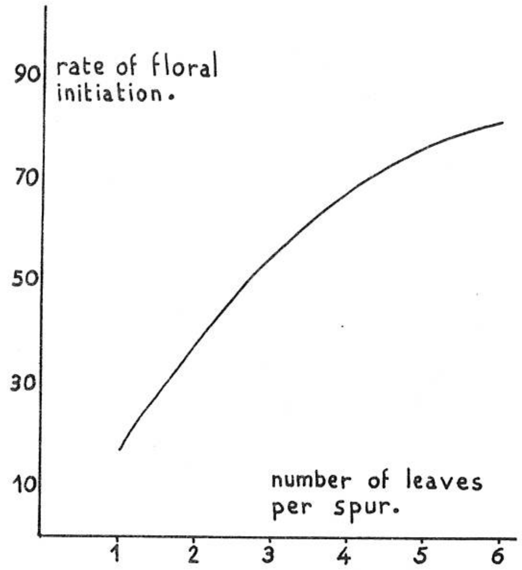

Figure 1 - Relationship between the number of leaves per spur and the rate of floral initiation in 'Williams'.

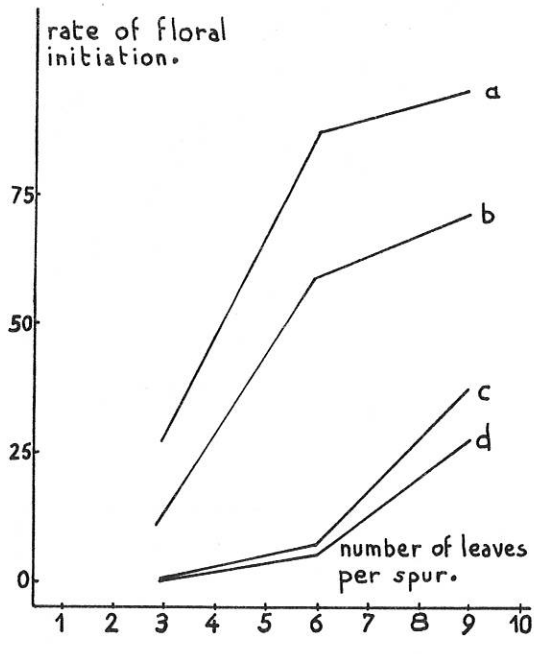

Figure 2 - Relationship between the number of leaves per spur and the rate of floral initiation in 'Williams' for:
a - in 1963 - on fruitless bourses
d - in 1963 - on bourses with fruit
b - in 1965 - on fruitless bourses
c - in 1965 - on bourses with fruit

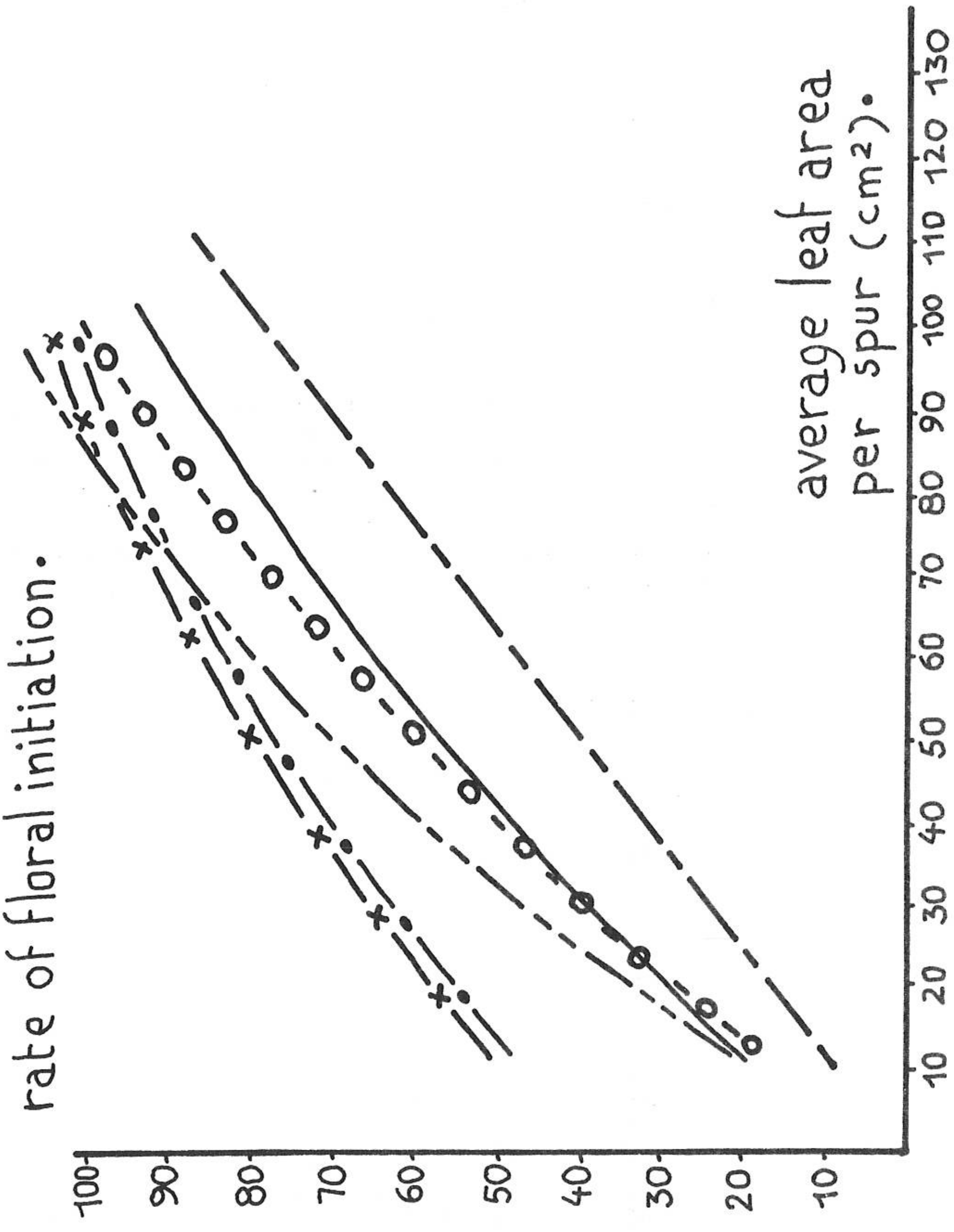

Figure 3 - Effects of growth substances on floral initiation on spurs of 'Williams':

- ———————— Control
- ——— – ——— – GA_3
- ——o———o—— TIBA
- ——— - - ——— - - CEPA
- ———x———x SADH
- ———•———• Chlormequat