Physiology of Fruit Trees

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Seasonal Cycle of Deciduous Fruit Trees

- Dormancy Period (mid autumn- mid winter)
- Release dormancy
- Accumulation of heat requirement
- Growth Period (early spring- early autumn)

Dormancy

Type of dormancy:

- Endo-dormancy (Rest, Winter dormancy)
- Eco-dormancy (Quiescence, Imposed dormancy)
- Ecto-dormancy (Para-Dormancy, Correlated Dormancy)

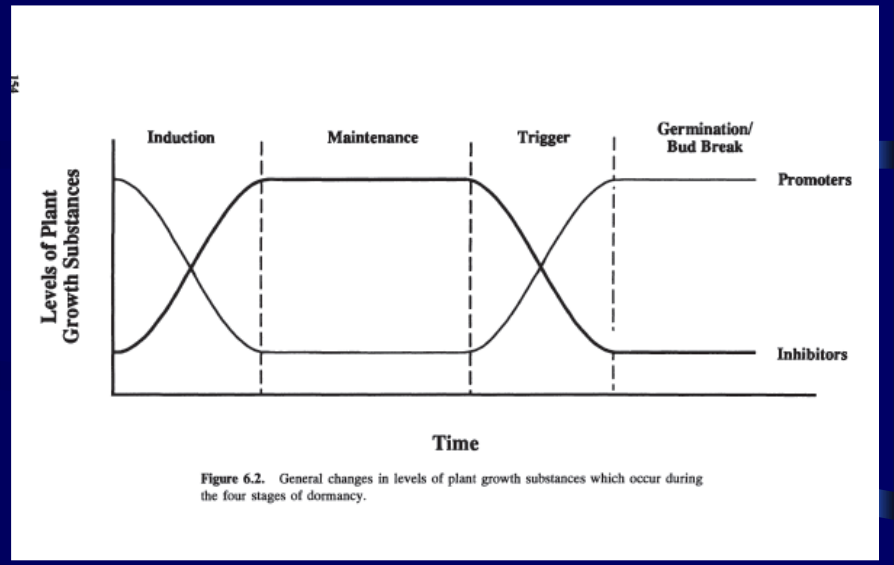
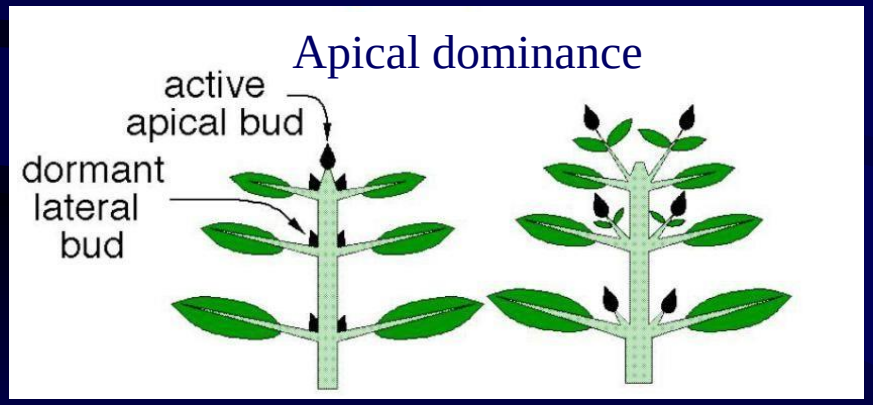


Figure 6.2. General changes in levels of plant growth substances which occur during the four stages of dormancy.



Flower Bud Dormancy

Dormancy is overcome by a period of chilling temperatures (Chilling Requirement)

Type of Tree	Approximate Hours	Equivalent Time in Days or Weeks if Continuously Exposed to 7.2 °C/45 °F or Below
Almond	200–300	8–13 days
Apple	1200–1500	7–9 weeks
Apricot	700–1000	4–6 weeks
Cherry, sour	1200	7 weeks
Cherry, sweet	1100–1300	6–8 weeks
Chestnut	300–400	2–3 weeks
Fig	few hours	—
Filbert (Hazelnut)	1500	9 weeks
Kiwifruit	600–850	3.5–5 weeks
Olive	200–300	8–13 days
Peach/Nectarine	650–850	4–5 weeks
Pear	1200–1500	7–9 weeks
Pecan	400–500	3–4 weeks
Persimmon	<100	4 days
Pistachio	1000	6 weeks
Plum, American	3600	5 months
Plum, European	800–1100	5–6 weeks
Plum, Japanese	700–100	4–6 weeks

The chilling requirement is measured using mathematical models

- Utah Model (Richardson)
- Low Chilling Model
- North Carolina Model

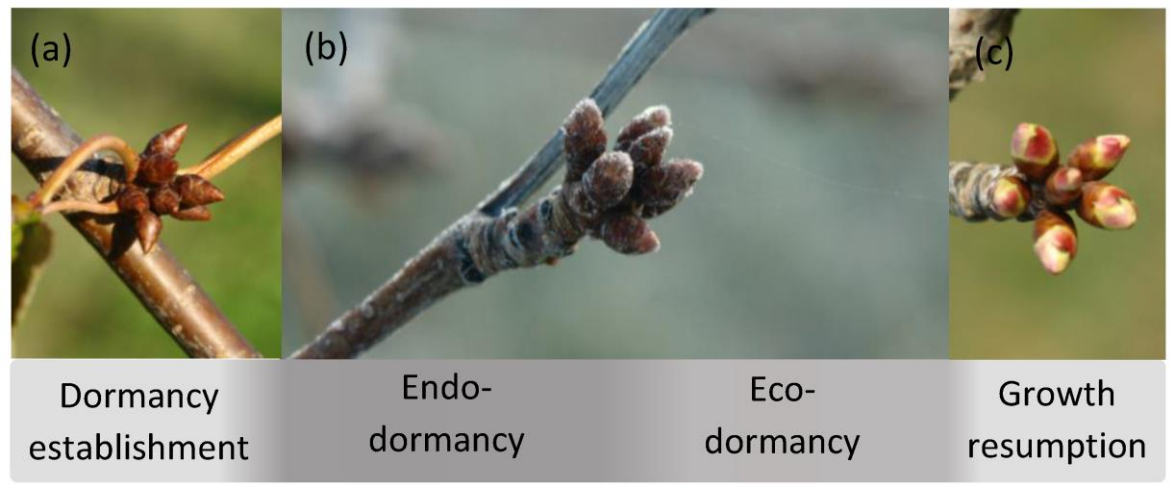
Table 1: Chill unit factors (CUF) used with Utah (UT), Low chilling (LC) and North Carolina (NC) models.

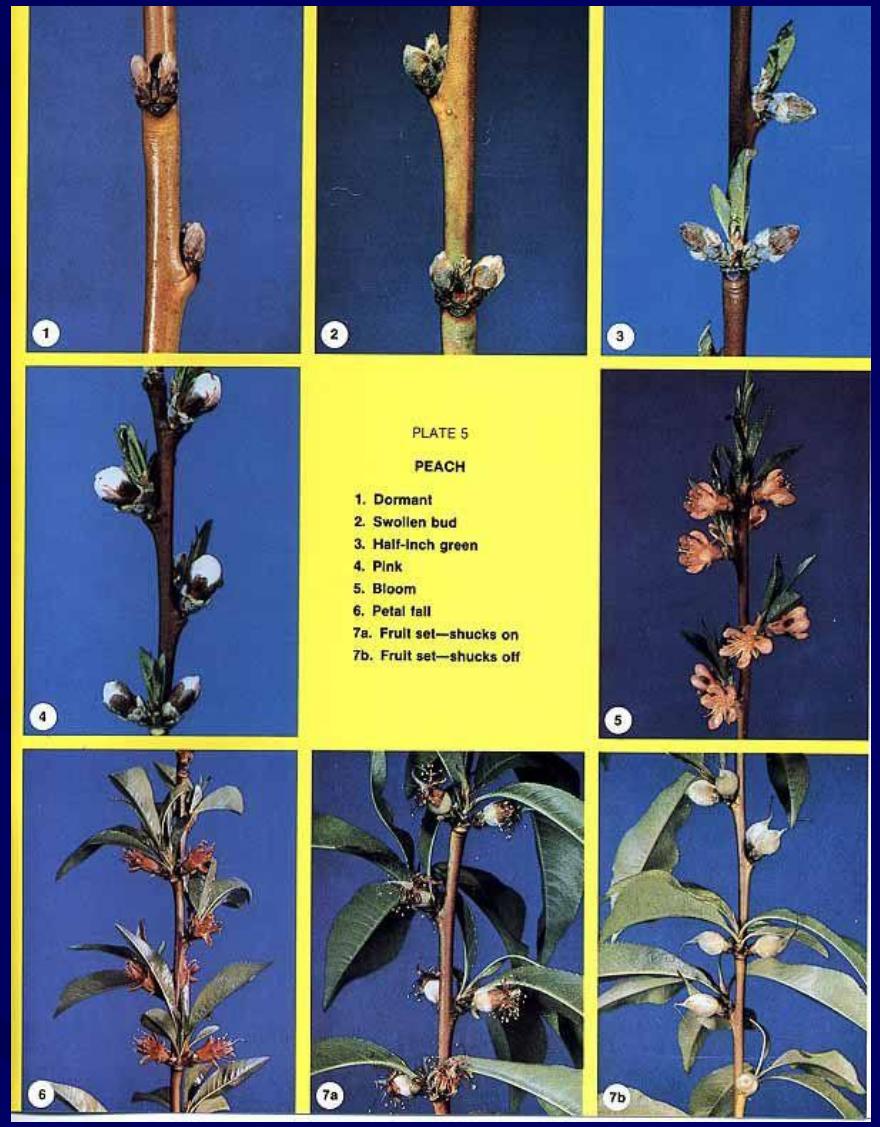
Utah Model (UT)		Low Chilling Model (LC)		North Carolina Model (NC)	
Temperature (^{0}C)	Chill Unit Factor (CUF)	Temperature (^{0}C)	Chill Unit Factor (CUF)	Temperature (^{0}C)	Chill Unit Factor (CUF)
<1.5	0	≤1.7	0	≤1.5	0
1.5-2.4	0.5	1.8-7.9	0.5	1.6-7.1	0.5
2.5-9.1	1	8-13.9	1	7.2-12.9	1
9.2-12.4	0.5	14-16.9	0.5	13-14.6	0.5
12.5-15.9	0	17-19.4	0	16.5-18.9	0
16-18	-0.5	19.5-21.4	-0.5	19-20.6	-0.5
>18	-1	≥21.5	-1	20.7-22	-1
				22.1-23.2	-1.5
				≥23.3	-2

(Adapted from Carla *et al.*, 2004)

Seasonal Cycle of Deciduous Fruit Trees

- 1-Buds swelling phase





Critical Temperatures for Frost Damage on Fruit Trees

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Critical Temperatures for Frost Damage on Fruit Trees

Marion Murray, IPM Project Leader

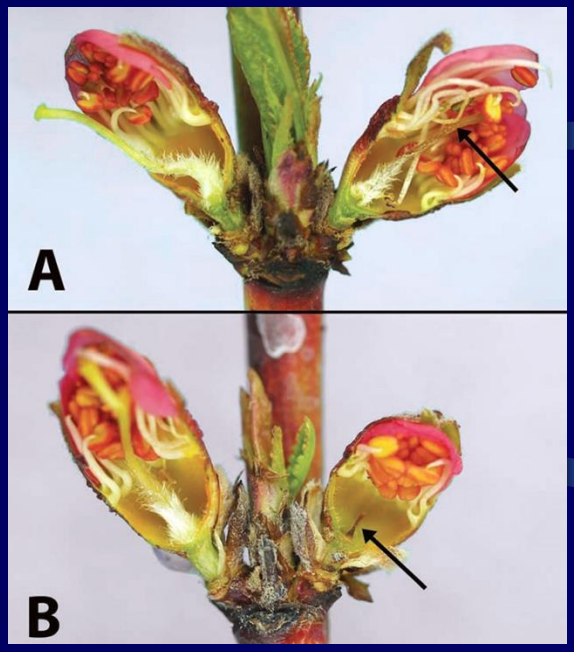
The following table, developed by Washington State University, lists Fahrenheit temperatures for each stage of development at which 10% and 90% bud kill occurs after 30 minutes exposure. The percentage bud kill which causes crop reduction will vary with each crop. For example, to have a full crop of cherries requires well over 50% bud survival in most years, while apples, pears, and peaches may only need 10-15% bud survival.

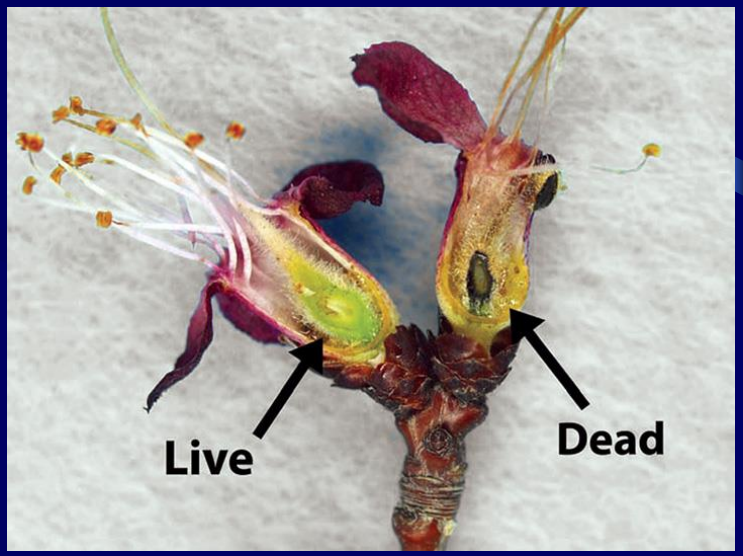
APPLE

	Silver Tip	Green Tip	Half-Inch Green	Tight Cluster	First Pink (Pink)	Full Pink (Open Cluster)	First Bloom (King Bloom)	Full Bloom and Post-bloom
10%	15	18	23	27	28	28	28	28
90%	2	10	15	21	24	25	25	25

PEAR

	Swollen Bud (Scale Separation)	Bud Burst (Blossom Buds Exposed)	Green Cluster (Tight Cluster)	White Bud (First White, Popcorn)	Full White	First Bloom (King Blossom)	Full Bloom	Petal Fall (Post-bloom)
10%	15	20	24	25	26	27	28	28
90%	0	6	15	19	22	23	24	24

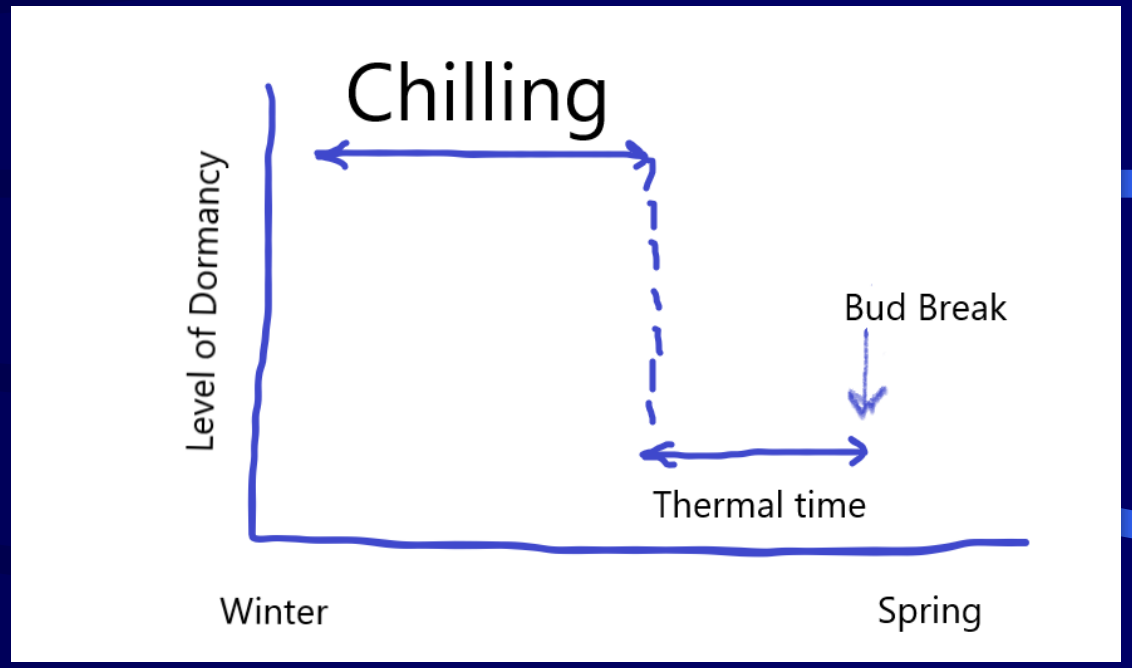




2- Bud break (Bud burst) phase

Thermal time (Thermal unit)

- Growth Degree Days (GDD)
- Growth Degree Hours (GDH)



$$\mathrm{GDH} = \sum_{\text{Bud Break}}^{\text{End of Dormancy}} \left[\sum_{0}^{24} \left(T_{\mathrm{h}} - 4.4\,^{\circ}\mathrm{C} \right) \right]$$

Base Temperature

Effect of chilling requirement and heat requirement in date of bud break in pistachio trees

Table Chilling and heat requirements of pistachio cultivars

Type of bud		Cultivar	Year	Chilling requirement (h)	Heat requirement (GDH)	Date of bud break
Flower	1	Kale-Ghuchi	2007	750	8 852	3 April
			2008	800	9 324	27 March
	3	Owhadi	2007	1 000	13 320	8 April
			2008	1 050	12 871	29 March
	2	Ahmad-Aghaei	2007	900	12 432	10April
			2008	850	11 988	28 March
	4	Akbari	2007	1 200	15 420	18 April
			2008	1 200	14 208	8 April
Vegetative		Kale-Ghuchi	2007	900	9 768	5 April
			2008	950	9 637	29 March
		Owhadi	2007	1 200	11 100	5 April
			2008	1 250	11 520	28 March
		Ahmad-Aghaei	2007	1 050	10 656	8 April
			2008	1 050	10 874	27 March
		Akbari	2007	1 400	12 544	12 April
			2008	1 400	11 863	6 April

From: Rahemi and Pakkish (2009)

TABLE I

Dates and the number of days' delay in 1979 of attaining different stages of fruit bud development in control and watered trees. The bud development of the watered trees was assessed for the whole tree (average) and on well-wetted sectors of the tree.

Stage of fruit bud development	Date of attainment			Number of days' delay	
	Control	Average	Well-wetted	Average	Well-wetted
Mouse-ear	15 April	27 April	10 May	12	25
Green-cluster	26 April	9 May	16 May	13	20
Pink-bud	8 May	16 May	21 May	8	13
First bloom	14 May	20 May	28 May	6	14
Full bloom	16 May	25 May	30 May	9	14

From: Hamer, P. J. C. (1981).

Genetic Control of Blooming Time

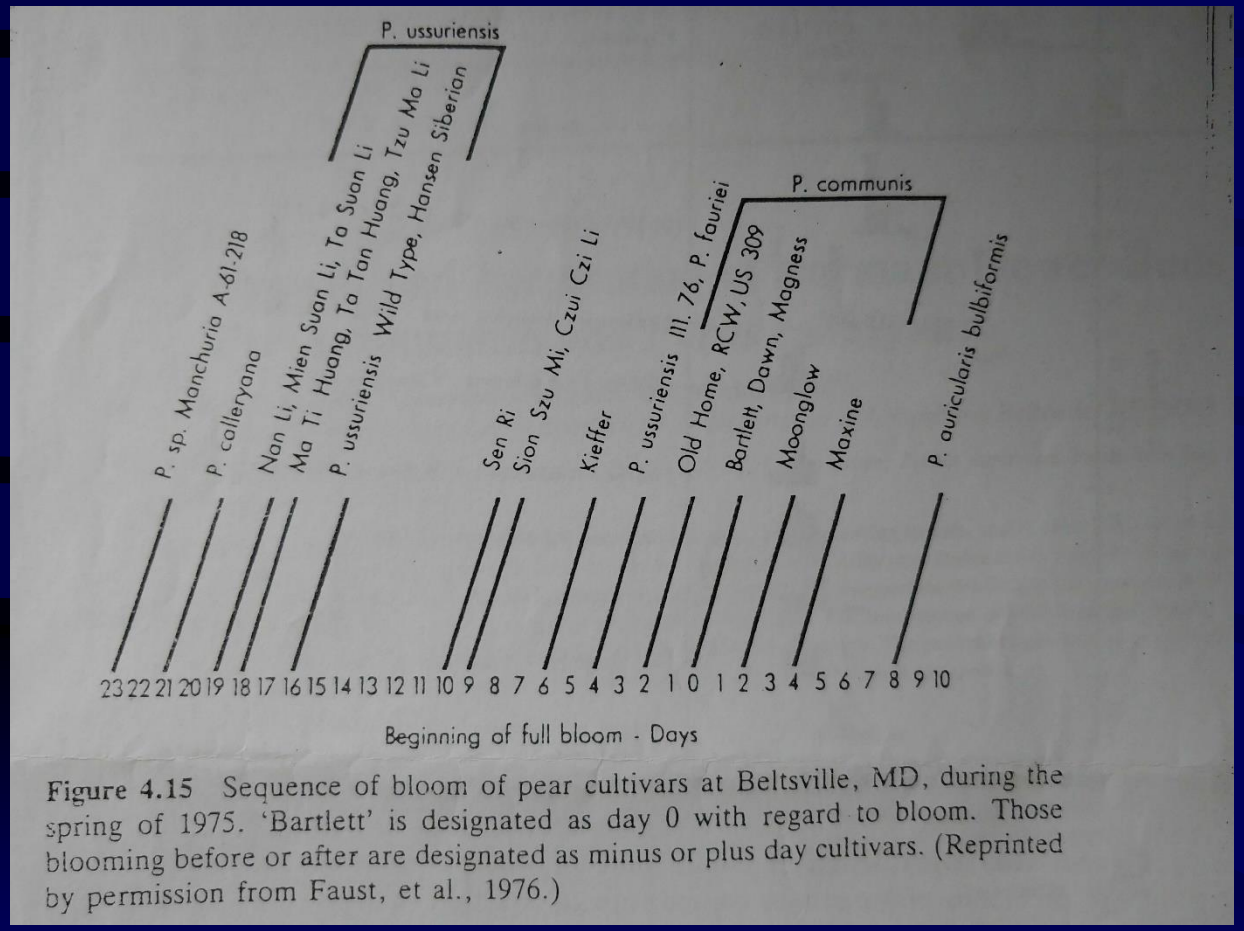
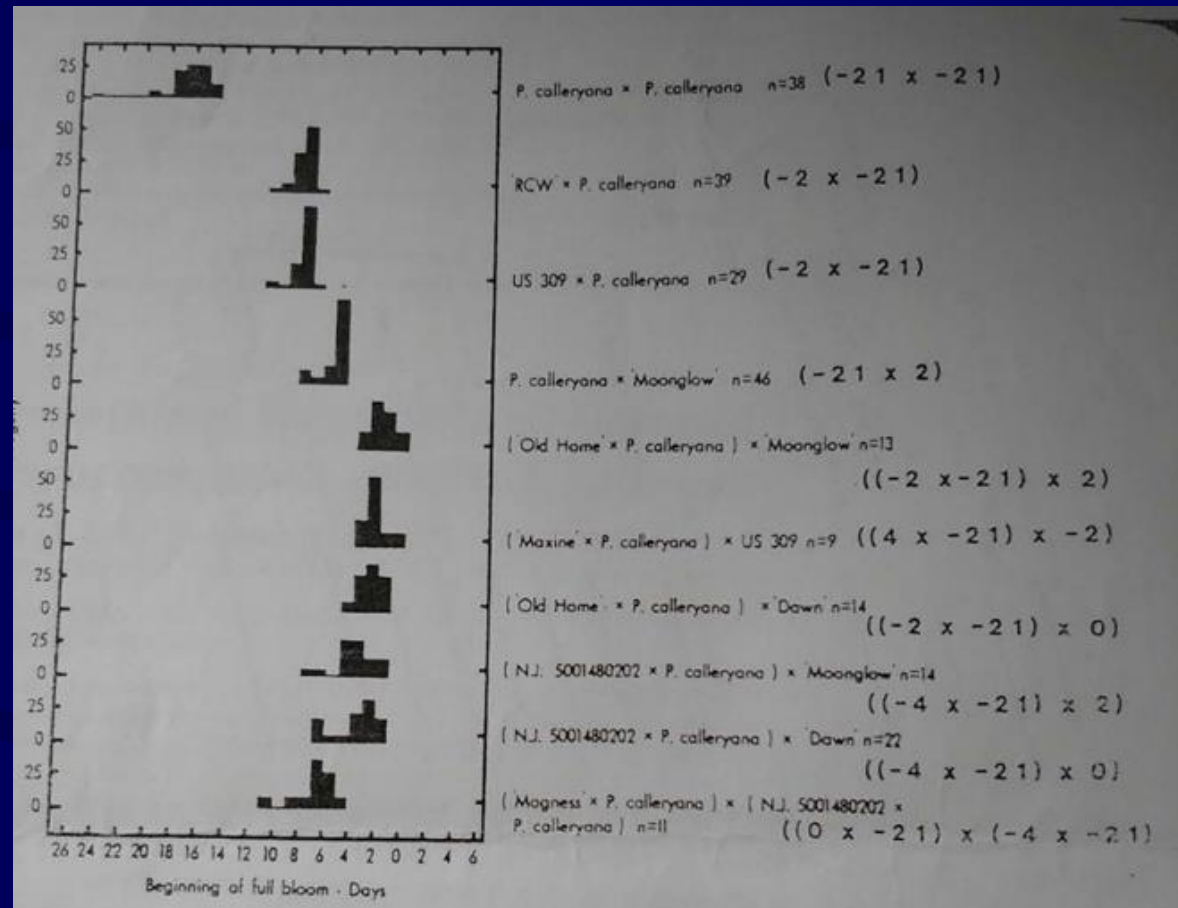


Figure 4.15 Sequence of bloom of pear cultivars at Beltsville, MD, during the spring of 1975. 'Bartlett' is designated as day 0 with regard to bloom. Those blooming before or after are designated as minus or plus day cultivars. (Reprinted by permission from Faust, et al., 1976.)



gure 4.16 Distribution of bloom time of various progenies of pear hybrids. ays of bloom of parents in comparison to 'Bartlett' are given in parentheses eprinted by permission from Faust, et al., 1976.)

Flowering Time

- Chilling Requirement Hours
- Heat Requirement Hours
- Genetic
- Plant Growth Regulators (Cytokinins such as Benzyladenin)
- Respiration of Dormant Flower Buds
    - Cytochrome Oxidase System (COS, General Respiration)
    - Cyanide-Resistant Respiration (CRR)
        - *Energy: CRR 1/3 less than COS
        - * Temperature: CRR lower sensitive to low temperature