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Research Centre for Horticulture
Institute of Pomology
DK-5792 Årslev

Occurence of dead flower buds in the sour cherry cultivar 'Stevnsbaer'

Døde blomsterknopper i surkirsebærsorten 'Stevnsbær'

B. Mortensen[1)], J. Grauslund and P. Hansen[2)]

Summary
The occurrence of dead flower buds may be a serious problem in 'Stevnsbaer' in some years and orchards. Investigations revealed, however, that also in normal buds a proportion of the flowers die before anthesis. Flower buds were dissected under a microscope at monthly intervals from October to April. The first signs of damage to flowers were seen as early as November. Rate of mortality varied between 30 and 80%, but the results exclude that frost damage is the principal cause of flower death. Long shoots have more dead flowers than short shoots, and higher mortality near the tip of the shoot than at the base. Mortality was not related to the initial number of flowers per bud.

Key words: Sour cherry, 'Stevnsbaer', flower bud development, flower mortality, shoot length.

Resumé
I visse år findes mange døde blomsterknopper i 'Stevnsbær'. Prøver af blomsterknopper blev med 1 måneds intervaller undersøgt mikroskopisk. De første tegn på beskadigelser fandtes allerede i november, hvilket udelukker at vinter- eller forårsfrost kan være hovedårsagen til blomsterdød. Der var stor variation fra år til år og fra mark til mark i procent døde blomster. Lange skud har flere døde blomster end korte skud og desuden flest døde blomster nær spidsen af skuddet. Blomsterdød synes ikke at have forbindelse med det oprindelige antal blomster pr. knop.

Nøgleord: Surkirsebær, 'Stevnsbær', blomsterudvikling, blomsterdød, skudlængde.

1) Adress: Havebrugsskolen, Vilvorde, DK-4340 Tølløse.
2) Adress: Havebrugsinstituttet, Den Kgl. Vetr.- og Landbohøjskole, Rolighedsvej 23, DK-1958 Frederiksberg C

Introduction

The distribution of flower and leaf buds on different shoot types of 'Stevnsbaer' has been determined (5). On shoots shorter than 20 cm all buds are flower buds, except the apical bud, which is always vegetative. On shoots longer than 20 cm leaf buds increase in number, and the longer the shoot the greater the proportion of leaf buds.

In some years flower bud development seems to be in some way impaired, since some buds fail to develop all their flowers to the full bloom stage. At flowering time 'dead' buds, i.e. flower buds with no fully developed flowers, are seen along with buds having 1–2 usually poorly developed flowers and buds having 3–5 fully developed flowers. Flower buds with no visible flowers at flowering time are called dead buds, since they rarely contain any vegetative primordia and therefore typically give rise to bare parts of the shoots.

The reason for poor flower development in 'Stevnsbaer' is not known, but it may be related to factors affecting growth and initiation of flowers, since long shoots have buds with reduced numbers of flowers near the tip of the shoot (5), and these flowers have a lower fruit set potential (4).

The present investigation was undertaken to find out at what stage flower development is arrested. Further aims have been to see the variation in the proportion of dead buds between short and long shoots, and between years and different orchards. Cold injury has been supposed to cause flower mortality, so low situated orchards with a greater frost risk were compared to higher situated ones. Since bacterial canker may also restrict bud development it was decided to see if copper-containing sprays (Cuprotox, Cudol), supposed to control the disease, could improve flower bud survival.

Materials and Methods

Location and treatment of the experimental trees together with sampling dates are shown in Table 1. In each field six trees were selected, and at each sampling date the buds on one short shoot (10 cm) and one long shoot (20–40 cm) per tree were examined under a stereo-microscope. Bud scales were removed and the nature of the bud (flower or leaf) determined. In flower buds the following types of flowers were found: healthy (green) flowers, partly brown-coloured flowers, dead flowers

Table 1. Location of trees, treatments, and sampling dates.
Oversigt over forsøgenes placering, behandlinger og prøveudtagninger.

Year *År*	Orchard *Mark*	Location *Placering*	»Treatment« *»Behandling«*	Tree age, years *Træ alder, år*	Dates of sampling *Prøveudtagninger*
1980–81	A	V. Hæsinge	Low Situation	12	*9 samples:* 15/10, 15/11, 10/12
	B	do	High –	8	6/1, 25/1, 20/2,
	C	Blangstedgaard	Low –	9	18/3, 25/4
	D	do	High –	9	
1981–82	A2	V. Hæsinge	No copper-spray	13	*7 samples:* 18/10, 22/11,
	B2	do	3 sprays of 0.25% Cuprotox (2/10, 16/10, 12/11)	13	17/12, 20/1, 23/2, 27/3, 30/4
	C2	Blangstedgaard	3 sprays of 0.50% Cudol (15/10, 16/10, 12/11)	9	
	D2	do	3 sprays of 0.50% Cuprotox	9	
	E2	do	1 spray of 0.25% Cuprotox (12/11)	9	
1982–83	F1	Årslev		4	*3 samples:* 20/2, 18/3, 7/4
1983–84:	F2	Årslev		5	*2 samples:* 26/2, 24/4
1984–85	G1	Tåstrup (Pometet)		15	*3 samples:* 20/9, 8/10, 1/11

Table 2. Stages of flower bud development.
Udviklingsstadier for blomsterknopper.

Stage *Stadium*	Description *Beskrivelse*
1	Sepals visible
2	Sepals and petals visible
3	Sepals, petals and stamens visible
4	Sepals, petals, stamens and style visible
5	As 4, style with an arched stigma
6	Flower buds in tight cluster, stamens with yellow anthers

The stages roughly correspond to stages D–H of *Watanabe* and *Umetsu* (6).

(all parts of the flower brown and completed faded), and undeveloped flowers (flowers arrested in development at a very early stage). The stage of flower development of healthy flowers was determined using the scale in Table 2.

Results

1. Distribution of buds at flowering time

The distribution of leaf buds, flower buds and dead buds at flowering time is shown in Fig. 1 for all locations, years and shoot types. The proportion of dead buds was high in orchards A–E investigated in 1981 and 1982. Long shoots generally have more leaf buds and dead buds, but there is a considerable variation in distribution according to year and location. Flower mortality is not fully expressed by the proportion of dead buds, since buds categorized as flower buds may contain dead flowers in addition to healthy ones. However, the distribution shown in Fig. 1 reflects the visual impression of the buds at flowering time.

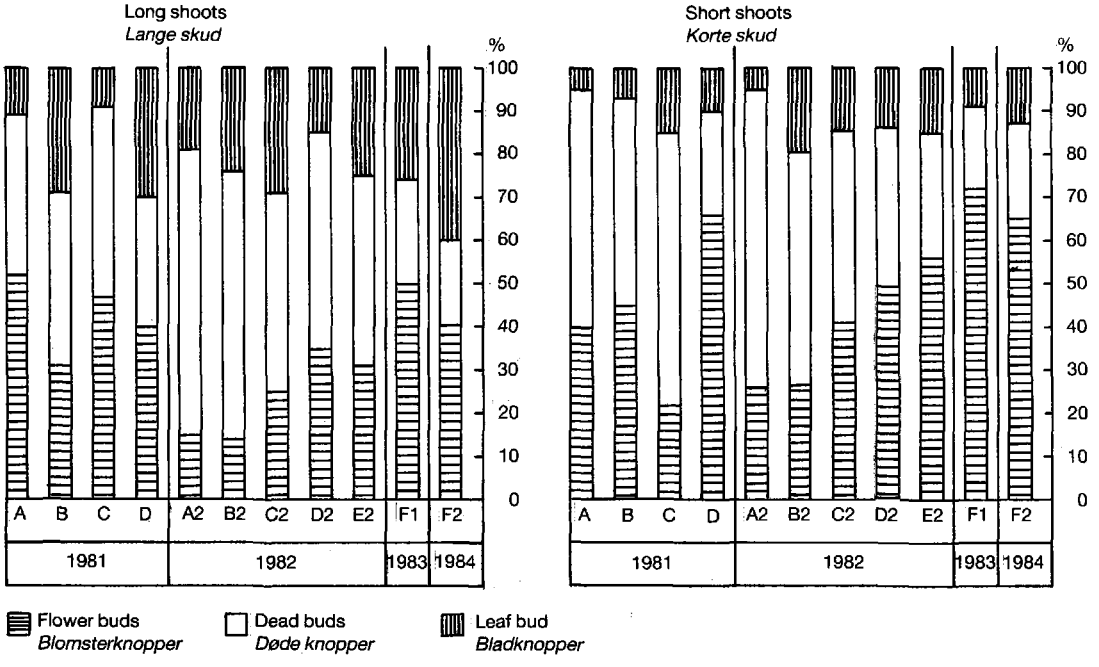

Fig. 1. The distribution of flower buds, dead buds and leaf buds in April. A–F2, see Table 1.
Fordelingen af blomsterknopper, døde knopper og bladknopper i April. A–F2, se tabel 1.

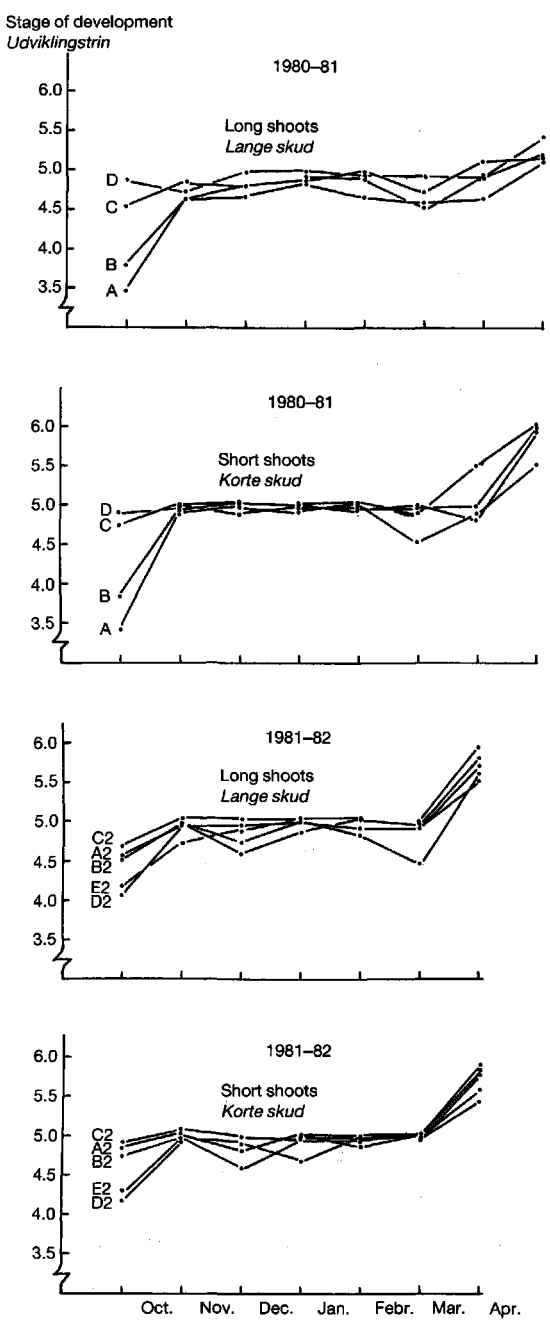

Fig. 2. Flower development stages from October to April on long and short shoots for two years. Stages, see Table 2.

Blomsternes udviklingstrin fra oktober til april i lange og korte skud i 2 år. Stadier, se tabel 2.

2. Flower development

The stage of flower development was assessed at each sampling date. Before entering dormancy all flowers had reached stage 4–5, i.e. all parts, including the style, were visible, Fig. 2. Some differences between orchards were found in the early stages (October), and this was true for both long and short shoots.

In a separate study, flower development on long and short shoots was determined on three dates from late September till early November, Fig. 3. On 20 September, flowers on long shoots were less developed near the base and near the tip of the shoot, whereas flowers at the middle of long shoots had reached a stage similar to flowers on short shoots. The difference diminishes later on, and on 1 November all flowers on short and long shoots had reached the same stage (4–5), i.e. the stage found in November in two previous years (Fig. 2).

3. First appearance of dead flowers

Brown colouration of flower parts was first seen in November and was taken as the first visible sign of disturbed flower development. Nearly all flowers were healthy in October (Fig. 4). During November – January there was an increase in the proportion of partly brown-coloured flowers. In February – March many flowers died (all parts of the flower had turned brown). Occasionally, a small number of very small, undeveloped flowers was found.

Partly brown-coloured and completely brown-coloured flowers have been treated as 'dead' flowers in Fig. 5, where results from two years are shown. Regardless of year, location, treatment, and shoot length, damage to flowers starts in November. Short shoots show more variation between locations and treatments, but generally short shoots have a lower proportion of dead flowers than long shoots. There is no clear difference between low situated orchards (A, C), and higher situated ones (B, D). The trees at Blangstedgaard (C2, D2, E2) had fewer dead flowers compared to V.-Hæsinge (A2, B2) in 1981–82.

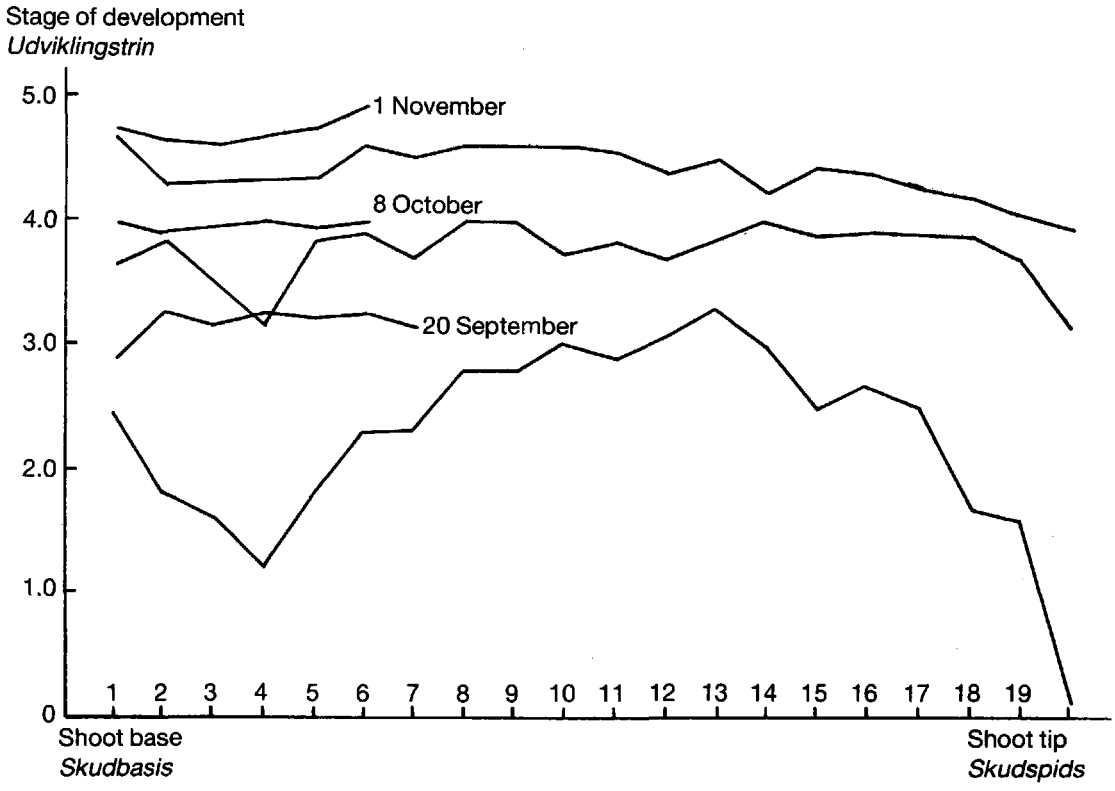

Fig. 3. Flower development stages at different flower bud positions on long and short shoots and on three dates in Autumn 1984. Stages, see Table 2.

Blomsternes udviklingstrin ved forskellige knoppositioner på lange og korte skud på tre tidspunkter efterår 1984. Stadier, se tabel 2.

The different copper-containing sprays did not clearly affect flower survival. However, three sprays with high concentrations (0.50%) accelerated leaf-fall by about one week compared to the standard treatment (one spray, 0.25%).

In the last three years samples were not taken throughout the dormant season, so it is not possible to follow the appearance of dead flowers during these years. 40–50% of the flowers were dead in April 1983 (F1) and 1984 (F2) (results not shown). So, the mortality rate was generally lower here than in the preceeding years.

4. Winter and spring frost

Low winter-temperatures may cause damage to flower buds. Fig. 6 shows mean and minimum temperatures (10-day-averages) for four growing seasons. The winter 1981–82 was extremely cold with temperatures below –20°C during December and January. Although this winter was considerably colder than the preceeding one, the course of damage to flowers was very similar for these years (Fig. 5). Therefore, no causal relationship between winter frost damage and flower mortality could be established.

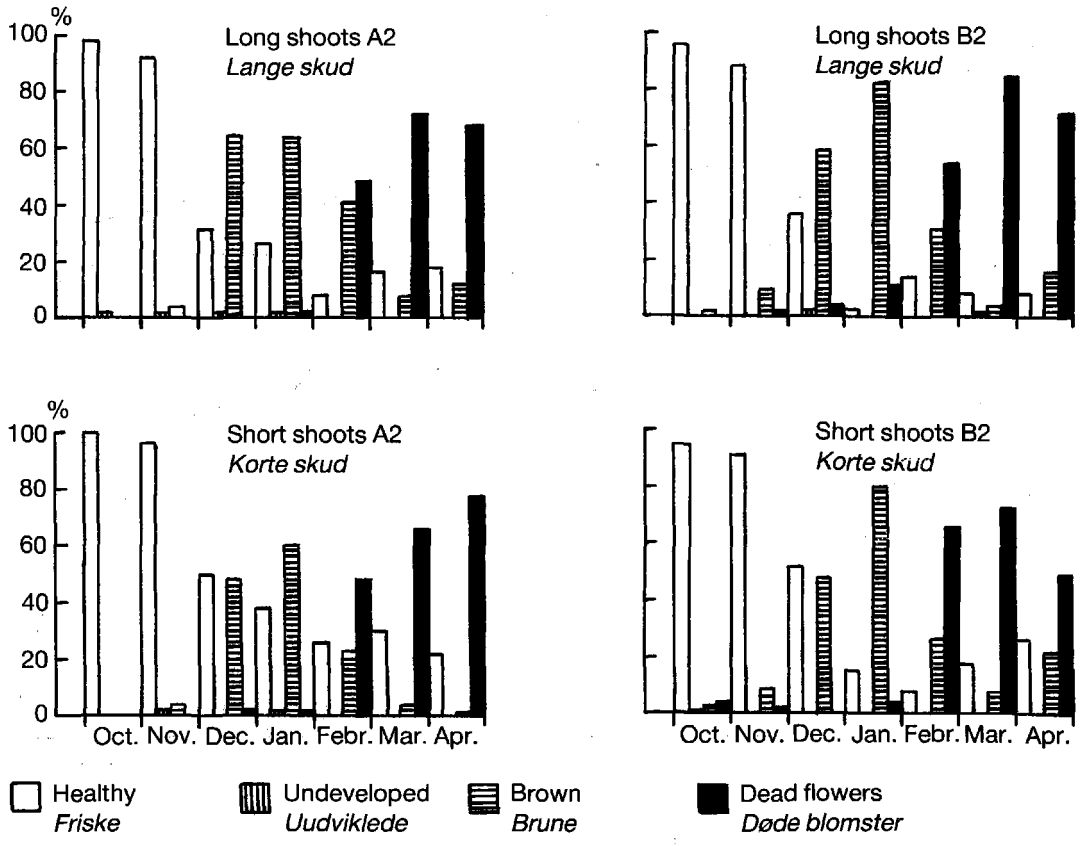

Fig. 4. Distribution of healthy, brown-coloured, dead, and undeveloped flowers respectively, from October to April 1981–82 in two orchards.

Fordelingen af henholdsvis friske, brune, døde og uudviklede blomster fra oktober til april 1981–82 i to marker.

5. Flower survival and initial number of flowers per bud

Table 3 shows the proportion of flower buds with either three, four or five flowers originally present per bud. On an average, buds with four flowers are most frequent, followed by buds with five and three flowers. But there are exceptions for certain locations, which have most buds with five flowers (B, F1, F2), at least in some shoot sections. The same trees may exhibit a different dominant flower number from year to year, since location A (1980) is the same as location A2 and B2 (1981). A small proportion of the buds had either less than three or more than five flowers.

The relation between flower number initially present per bud and flower survival is illustrated in Table 4. Long shoots have a higher flower mortality and hence fewer healthy flowers left at flowering time. But there seems to be no clear relation between original flower number and flower mortality rate.

Flower buds at different positions on long shoots, however, show clear differences in mortality, Fig. 7. Less flowers survive towards the top of the shoot, especially in buds with initial numbers of three or four flowers.

Table 3. The distribution of flower buds with three, four or five flowers (initial numbers) on short shoots and on different sections of long shoots. Per cent of total number of flower buds per shoot category. Average of all sampling dates.

Fordelingen af blomsterknopper med tre, fire eller fem blomster (oprindeligt antal) på korte skud og på forskellige dele af lange skud. Procent af alle blomsterknopper på hver skudinddeling. Gennemsnit af alle udtagninger.

Flower number *Antal blomster*		Short shoots *Korte skud*			Long shoots *Lange skud*								
		3	4	5	3	4	5	3	4	5	3	4	5
Year *År*	Orchard *Mark*					Base *Basis*			Middle *Midt på*			Tip *Top*	
1980–81	A	17	49	27	8	44	44	5	38	50	6	49	38
	B	4	46	44	8	33	50	4	28	58	4	33	49
	C	18	68	12	22	65	9	13	60	25	3	58	32
	D	25	68	4	40	53	7	13	74	13	19	62	18
1981–82	A2	32	54	12	22	67	9	15	67	16	20	60	19
	B2	39	45	10	24	59	9	26	59	14	25	59	21
	C2	19	57	22	16	62	19	12	63	23	16	63	19
	D2	16	54	25	9	60	29	12	59	27	15	52	29
	E2	14	59	25	13	58	26	22	48	28	9	62	26
1983	F1	19	56	22	7	44	37	6	27	59	5	43	48
1984	F2	6	56	37	15	45	38	9	30	61	10	50	37
Average *Gns.*		19	56	22	17	54	25	12	50	34	12	54	31

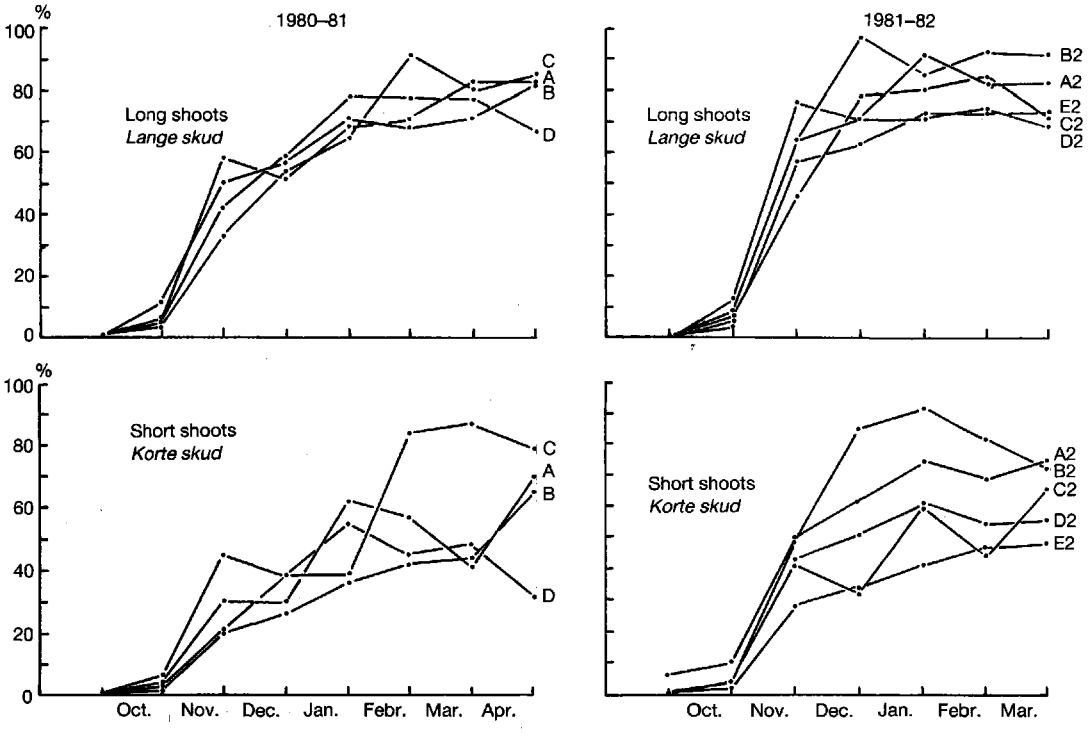

Fig. 5. Per cent 'dead' (partly + completely damaged) flowers in buds on long and short shoots from October to April for two years.

Procent 'døde' (delvis + helt beskadigede) blomster i knopper på lange og korte skud ved udtagning fra oktober til april i to år.

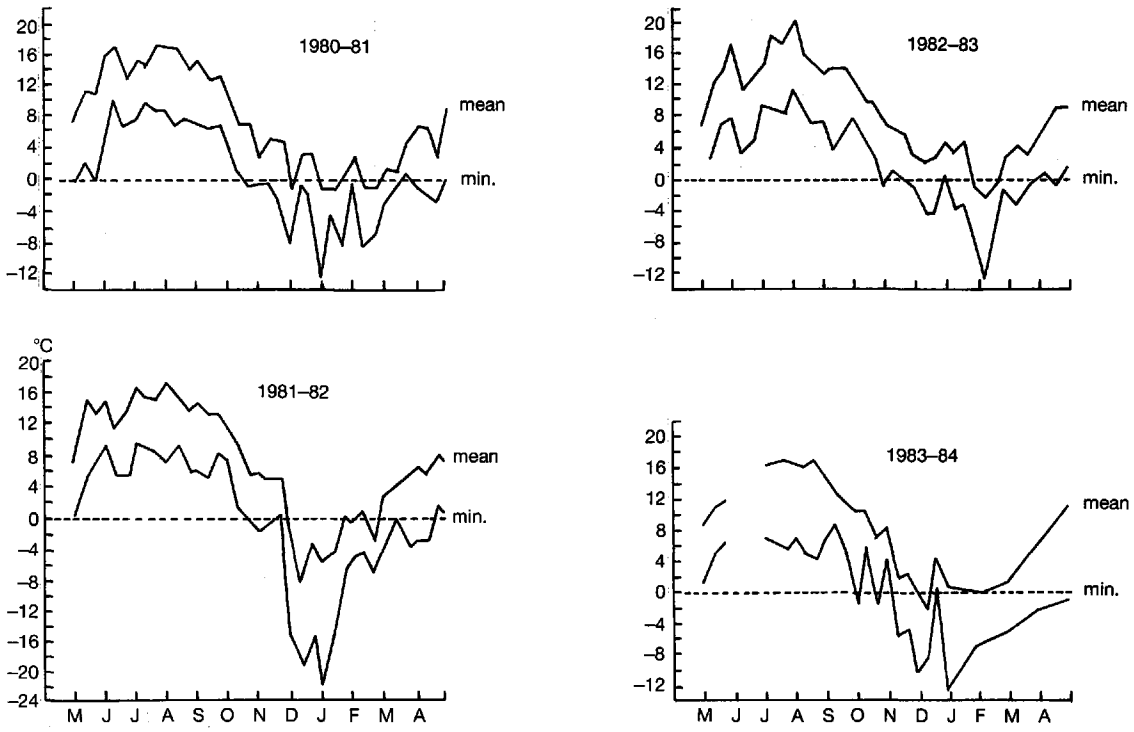

Fig. 6. Mean and minimum temperatures (10-day averages) at the Horticultural Research Centre, Årslev, for four years.
Gennemsnits- og minimumstemperatur (10-døgns gennemsnit) ved Havebrugscentret i Årslev gennem fire år.

Table 4. Per cent dead flowers in buds with initially three, four or five flowers present, and number of healthy flowers per bud in April. Average of all years and orchards.
Procent døde blomster i knopper med oprindeligt tre, fire eller fem blomster pr. knop, og antal friske blomster pr. knop i april. Gennemsnit af alle år og marker.

	Long shoots *Lange skud*		Short shoots *Korte skud*	
Number of flowers initially present per bud *Oprindeligt antal blomster pr. knop*	Per cent dead flowers *% døde blomster*	Healthy flowers per bud *Antal friske blomster pr. knop*	Per cent dead flowers *% døde blomster*	Healthy flowers per bud *Antal friske blomster pr. knop*
3	73	0.8	48	1.6
4	73	1.1	62	1.5
5	64	1.8	56	2.2

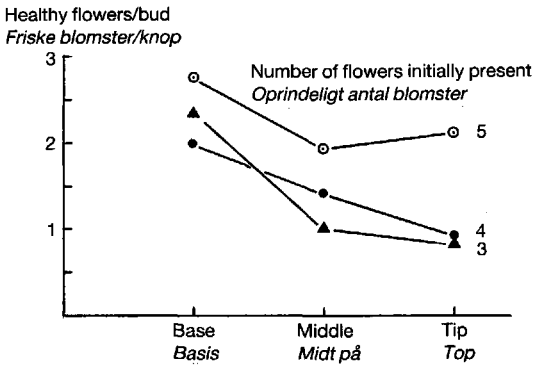

Fig. 7. Number of healthy flowers per bud in April on different sections of long shoots in relation to initial number of flowers per bud. Average of four years.

Antal friske blomster pr. knop i april på forskellige dele af lange skud i relation til det oprindelige antal blomster pr. knop. Gennemsnit af fire år.

Discussion

In agreement with observations on other cherry cultivars, 'Stevnsbaer'-flowers have differentiated all their flower parts before entering dormancy (7, 8). The first signs of damage to young flowers were unexpectedly found already in November. They appeared at the same time, two years running, in different orchards, on both short and long shoots. The subsequent rise in flower mortality during the winter was very similar for two years with very different frost severity. These results seem to exclude winter and spring frost as principal causes of flower mortality. Of course, severe frost in spring can cause flower death (3), and also winter frost may damage the buds, but this was not observed after the severe winter 1981–82 (2).

The variation in damage between years and orchards was considerable, but due to differences in tree age and growth conditions is it not possible to point out any likely causes of this variation. The fact that the two first years showed a much higher mortality of flowers than the two last years, could be related to climatic differences, but orchard factors may also have played a decisive role. Clones of 'Stevnsbaer' may differ with regard to the occurrence of dead flower buds (1).

Flower mortality was clearly related to shoot length with long shoots showing more dead flowers, especially near the tip of the shoot. Different sections of long shoots had about the same distribution of buds with three, four and five flowers initially present, while buds near the tip contained fewer surviving flowers. Fewer flowers in buds near the tip were also found previously (5), together with a reduced fruit set compared to buds near the base. So, late flower bud initiation seems to be detrimental to flower survival as well as to the quality of surviving flowers.

In agreement with general observations in 'Stevnsbaer'-orchards this study shows, that mortality of flowers varies greatly from year to year. The cause of flower death is not known, but the results point to the conclusion that factors prior to the dormant season may in some way be responsible for poor survival.

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