The effect of the limitation of insect pollination period on the fruit set and yield of temperate-zone fruit tree species

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Summary: The duration of effective bee pollination period was limited by caging flowering branches for shorter or longer time in blooming fruit trees in a number of experiments during the past decades. In the case of self-sterile fruit species and cultivars (apples, pears, quinces, some plums, some sour cherries) even partial limitation of the effective duration of bee pollination period significantly reduced the fruit set and the yield. In the case of self-fertile apricots the effect of the total and also the influence of partial limitation of bee pollination period was the same as in the case of the mentioned self-sterile fruits. On the other hand, in the case of another self-fertile fruits (some plums, some sour cherries), the effect of partial limitation of bee pollination period was usually small, but complete (or incomplete but strong) limitation of be pollination usually resulted in a strong reduction of yield. This means that not only self-sterile but also self-fertile fruits clearly depend on insect (bee) pollination. This is because pollen dehiscence of anthers and the receptive period of stigmas do not overlap in time within the individual flowers. Stigmas in self-fertile trees, therefore, need pollen carried by bees from another flowers of the same tree (or compatible pollen from another trees). Accordingly, additional bee pollination (moving bee colonies to the orchards in flower) is needed to all kinds of temperate-zone fruit tree species when bee visitation of plantations is not abundant enough for some reasons.

Introduction

Great many studies have reported on the fruit set and yield of fruit trees with and without bee pollination and these results are largely surveyed in the comprehensive books of *Free* (1970, 1993). It is largely accepted that insects are important pollinating agents for self-sterile fruit cultivars and it is also well known that weather and some another environmental factors can influence bee activity at blooming fruit plantations and this affects the fruit set and yield. In spite of this fact little effort was made to explore the effect of the effective time (duration) of insect pollination period on yield. This item was dealt with by *Benedek* and *Bánk* in a single experiment for apple (in: *Benedek* et al. 1974) and by *Roversi* and *Ughini* (1986) for sweet cherry. Also red clover was studied from this point of view by *Benedek* et al. (1977). Results of these studies corroborated to earlier statements on the importance of insect pollination in the fruit set and yield of self-sterile plant species, but indicated that insects play an indispensable role in the case of self-fertile fruit cultivars, too, as pollen vectors (*Benedek* and *Nyéki* 1996). In fruit growing circles, however, there are contradicting opinions in the latter aspect. Therefore, findings on the importance of pollinating insects at self-fertile fruits needed more evidence.

For the lack of enough information we made extensive studies with apple and some additional experiments with plum (*Benedek* et al. 1994) and sour cherry (*Benedek* et al. 1990) in the late eighties. Several additional new experiments have also been implemented since than. This paper summarises the results of these experiments to clear the overall role of bee pollination in the case of self-fertile fruits as well as to explore the effect of the duration of effective bee pollination period on self-sterile fruit trees.

Table 1 Yield of apple cultivars as affected by the effective duration of insect pollination (Tamásipuszta, Szigetcsép, Ráckeve, 1972, 1987, 1988)

Cultivar	Experiment (site and year)	Yield from 50 flowers (n=16)						Significance level of yield differences between treatments (p<)
		Free pollination (no caging)		Partial limitation (caged from the 5th day of blooming)		Total limitation (caged during the whole blooming period)		
		No. of apples	total yield (q)	No. of apples	total yield (q)	No. of apples	total yield (q)	
Jonathan	T-1972	10±1	1469±148	5±1	751±144	0.2±0.1	41±23	0.05
	Sz-1987	7±1	870±100	3±1	390± 80	0.05±0.05	10±10	0.05
Idared	R-1988	7±1	1052±219	4±1	565±183	0.5±0.5	76±67	0.05
Jonnee	R7-1987	4±1	550±80	3±1	370±80	1±0.3	124±40	nil
R10-1987	3±1	340±60	3±1	280±50	1±0.3	136±40	nil	
R7-1988	19±3	1668±273	4±2	352±188	0	0	0.05	
	R10-1988	21±3	1895±199	4±1	363±125	0	0	0.01
Starkrimson	R-1987	7±1	890±110	2±1	370±50	1±0.4	60±30	0.05
Delicious	Sz-1987	3±1	420±60	1±1	130±40	0.1±0.1	10±10	0.05
R-1988	4±1	594±186	01±0.1.	33±33	0	0	0.01	
Wellspur	R-1987	5±1	650±60	2±1	320±80	0.06±0.06	60±60	0.1

Experimental sites:T= Tamásipuszta (Eastern Hungary)
R= Ráckeve (R7 and R10 are different orchards) (Central Hungary)
Sz= Szigetcsép (Central Hungary)

Table 2 Fruit set and yield of apples as affected by the effective time of insect pollination (Cegléd, 1997)

Cultivar	Effective duration of insect pollination during the blooming period	Final set (per cent) (n=4)	Yield from 100 flowers (g) (n=4)	Mass of a single fruit (g)	No. of viable seeds per apple
Gala must	(1) 0 % open (caged)	0	0	–	–
I. plantation	(2) 50 % open (first)	6.5±3.8	722±401	108±9 (n=13)	7.4±0.2 (n=13)
	(3) 50 % open (second)	8.0±2.2	1050±316	131±0.3 (n=16)	6.2±0.5 (n=16)
	(4) 100 % open	6.6±6.0	440±440	75±7 (n=12)	6.6±0.8 (n=12)
Gala must	(1) 0 % open (caged)	0	0	–	–
II. plantation	(2) 50 % open (first)	8.5±1.0	745±108	87±9 (n=17)	5.3±0.6 (n=17)
	(3) 50 % open (second)	13.0±2.5	947±113	76±7 (n=23)	6.9±0.3 (n=23)
	(4) 100 % open	8.8±3.1	1002±283	105±10 (n=19)	8.1±0.3 (n=19)
Golden Delicious	(1) 0 % open (caged)	0	0	–	–
	(2) 50 % open (first)	12.5±3.3	960±291	91±4 (n=21)	7.7±0.4 (n=21)
	(3) 50 % open (second)	11.0±4.8	1010±433	90±3 (n=21)	7.4±0.4 (n=21)
	(4) 100 % open	12.0±3.4	1088±304	83±5 (n=25)	7.4±0.3 (n=25)
Golden Delicious	(1) 0 % open (caged)	0	0	–	–
Crielaard	(2) 50 % open (first)	12.0±4.0	845±296	65±5 (n=25)	6.4±0.4 (n=25)
	(3) 50 % open (second)	10.5±2.8	730±272	80±7 (n=20)	5.9±0.4 (n=20)
	(4) 100 % open	14.0±1.2	1123±92	78±3 (n=28)	6.8±0.4 (n=28)

Explanation:
(1): 0 % open (caged) = caged during the whole blooming
(2): 50 % open (first) = open in the fist half, caged during the second half of blooming
(3): 50 % open (second) = caged in the first half, open during the second half of blooming
(4): 100 % open = no caging, open pollination

Methods

Apiaries were moved to one side of he experimental orchards at the majority of the experiments just at the commencement of the blooming. Four trees of each tested cultivar were selected at different distances from the apiary at each orchard. Branches at the middle section of the crown were selected towards the four directions of the compass at each experimental tree. Treatments were applied at each tree at each of the four directions as follows: (1) 0% open (caged) = total limitation of bee pollination, caged with muslin bags during the whole blooming period , (2) 50% open, first = partial limitation, free pollination in the first half (or at the first few days) of the blooming and caged afterwards with bags of parchment paper, (3) 50% open, second = partial limitation, caged at the first half of the blooming and free pollination afterwards, (4) 100% open = free pollination, no caging.

Fruit set and yield was counted at branches. In the case of pome fruits the mean mass of fruits and the number of viable seeds per fruit were also measured in some experiments.

Table 3 Fruit set and yield of apples as affected by the effective time of insect pollination (Mosonmagyaróvár, 1997)

Cultivars	Effective duration of insect pollination during the blooming period	Final set (per cent) (n=4)	Mass of a single fruit (g)	No. of viable seeds per apple
Arlet	(1) 0 % open (caged)	0	0	–
	(2) 50 % open (first)	3.3±2.0	185 (n=1)	5 (n=1)
	(3) 50 % open (second)	7.5±6.2	163±23 (n=2)	6.0±1.0 (n=2)
	(4) 100 % open	16.9±3.2	*	*
Florina	(1) 0 % open (caged)	0	0	–
	(2) 50 % open (first)	14.0±4.1	163±16 (n=6)	5.3±2.1 (n=6)
	(3) 50 % open (second)	2.3±2.3	144±17 (n=4)	4.5±2.1 (n=4)
	(4) 100 % open	20.1±0.9	120±13 (n=3)	6.5±1.8 (n=9)

Explanation:
(1): 0 % open (caged) = caged during the whole blooming
(2): 50 % open (first) = open in the fist half, caged during the second half of blooming
(3): 50 % open (second) = caged in the first half, open during the second half of blooming
(4): 100 % open = no caging, open pollination
*destroyed

Table 4 Fruit set and yield of pears as affected by the effective time of insect pollination (Keszthely, 1997)

Cultivars	Effective duration of insect pollination during the blooming period	Final set (per cent) (n=3)	Mass of a single fruit (g)	No. of viable seeds per apple
Clapp	(1) 0 % open (caged)	0	-	-
	(2) 50 % open (first)	0	-	-
	(3) 50 % open (second)	0	-	-
	(4) 100 % open	3.2±1.5	776±35 (n=5)	7.8±0.3 (n=5)
Fétel apát	(1) 0 % open (caged)	0	-	-
	(2) 50 % open (first)	4.6±1.0	180±17 (n=51)	1.7±0.2
	(3) 50 % open (second)	2.0±1.5	18. ±5 (n=4)	0.5±0.5 (n=2)
	(4) 100 % open	9.3±1.8	178±8 (n=7)	1.1±0.9
Serres Olivér	(1) 0 % open (caged)	0	-	-
	(2) 50 % open (first)	0	-	-
	(3) 50 % open (second)	1.3±1.3	203±77 (n=)	8.3±0.4
	(4) 100 % open	2.6±1.4	214±1 (n=22)	8.2±0.3 (n=22)
Conference	(1) 0 % open (caged)	0	-	-
	(2) 50 % open (first)	10.6±1.1	192±43 (n=4)	2.5±0.5 (n=4)
	(3) 50 % open (second)	9.8±1.9	193±0.3 (n=20)	3.2±0.0 (n=20)
	(4) 100 % open	11.1±11.1	181±43 (n=22)	2.0±0.8 (n=22)
Vilmos	(1) 0 % open (caged)	0	-	-
	(2) 50 % open (first)	2.5±0.6	185 (n=1)	7 (n=1)
	(3) 50 % open (second)	0	-	-
	(4) 100 % open	8.3±3.3	182±22 (n=20)	7.9±2.0 (n=20)

Explanation: (1): 0 % open (caged) = caged during the whole blooming, (2): 50 % open (first) = open in the fist half, caged during the second half of blooming, (3): 50 % open (second) = caged in the first half, open during the second half of blooming, (4): 100 % open = no caging, open pollination

Results

Results are demonstrated in the tables for apples (*Tables 1–3*), pears (*Table 4*) quince (*Table 5*), apricots (*Table 6*), plums (*Tables 7–8*) and sour cherry (*Table 9*).

Apple: Apple cultivars tested are self-sterile. Total limitation of bee pollination (caging during the whole blooming period) resulted in no fruit set and no yield (*Tables 2–3*) or insignificant yield only (*Table 1*). In the latter experiment the insignificant set and yield probably was caused by the activity of tiny insects (trips, pollen beetles) that we were unable to exclude with the bag we used for caging. Partial limitation of bee pollination period gave smaller set and yield than free pollination except in two cases at Cegléd 1997, where branches covered in the first half of the blooming gave higher set and fruit than free pollination (*Table 2*). The reason of this might be the cold weather that prevailed in the first half of the blooming and this probably resulted in higher damage in open branches than on branches under the cover of parchment paper. The limitation of bee pollination period (caging) in the first half of the blooming (50% open second) was resulted in at least somewhat higher set and yield than the limitation (caging) in the second half of the flowering (50% open first) in four cases and the opposite happened at 2 occasion of the six experiments (*Tables 2–3*). Accordingly, the fist half of the blooming seems to be somewhat more important in yield formation than the second half of it, however, environmental conditions (weather) can greatly influence this process and so the opposite can happen in some occasions.

Pear: Total limitation of bee pollination gave no set and yield of cultivars tested (*Table 4*). At one cultivar no yield

Table 5 Fruit set and yield of quince as affected by the effective time of insect pollination (Újfehértó, 1997)

Cultivars	Effective duration of insect pollination during the blooming period	Final set (per cent) (n=4)	No. of fruits for 100 flowers (n=4)
Agersi	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	1.7±1.7	1.7±1.7
	(3) 50 % open (second)	19.9±6.3	15.8±4.1
	(4) 100 % open	14.9±7.1	14.9±7.1
Bereczki	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	2.9±2.9	2.9±2.9
	(3) 50 % open (second)	0	0
	(4) 100 % open	16.6±3.3	16.6±3.3
Bőtermő Bereczki	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	4.5±3.0	3.1±3.1
	(3) 50 % open (second)	6.4±2.7	6.4±2.7
	(4) 100 % open	37.5±3.1	36.9±3.1
Champion	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	0	0
	(3) 50 % open (second)	0	0
	(4) 100 % open	13.7±4.2	13.7±4.2
Konstantinápolyi	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	0	0
	(3) 50 % open (second)	1.2±1.2	1.2±1.2
	(4) 100 % open	11.5±3.4	11.5±3.4
Mezőtúri	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	17.4±6.1	15.8±4.7
	(3) 50 % open (second)	2.7±1.6	2.7±1.6
	(4) 100 % open	44.1±7.2	44.1±7.2

Explanation:
(1): 0 % open (caged) = caged during the whole blooming
(2): 50 % open (first) = open in the fist half, caged during the second half of blooming
(3): 50 % open (second) = caged in the first half, open during the second half of blooming
(4): 100 % open = no caging, open pollination

Table 6 Fruit set and yield of apricots as affected by the effective time of insect pollination (Cegléd, 1997)

Cultivars	Effective duration of insect pollination during the blooming period	Final set (per cent) (n=4)	No. of fruits for 100 flowers (n=4)
Piroska	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	0	0
	(3) 50 % open (second)	0	0
	(4) 100 % open	1.8±1	39±23
Bergeron	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	1.0±0.6	42±25
	(3) 50 % open (second)	0	0
	(4) 100 % open	2.5±2.5	96±96
CT 1652	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	0	0
	(3) 50 % open (second)	0	0
	(4) 100 % open	2.0±1.1	30±17
CT 2546	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	0	0
	(3) 50 % open (second)	0.5±0.5	6±6
	(4) 100 % open	3.5±2.2	65±49

Explanation:
(1): 0 % open (caged) = caged during the whole blooming
(2): 50 % open (first) = open in the fist half, caged during the second half of blooming
(3): 50 % open (second) = caged in the first half, open during the second half of blooming
(4): 100 % open = no caging, open pollination

was set also when the bee pollination period was partially limited. On the other hand, at the other cultivars tested partial limitation of the bee pollination period was resulted in a smaller set and yield than at the open pollination but the values were not insignificant because at least one of the two treatments of the partial limitation of the bee pollination period gave at least half as much set and yield as free pollination. At two cases partial limitation of the bee pollination period in the first half of the blooming (50% open second) gave more yield than the another kind of limitation (50% open first) but the opposite happened at the other two cases. This means the effect of the partial limitation of bee pollination was influenced by weather (the blooming period of cultivars differed slightly) instead of the sensitivity of pear trees against the limitation of bee pollination period at different part of their blooming period.

Quince: No information on the effect of the limitation bee pollination period on the fruit set and yield of quince in the literature. Results clearly show that in lack of bee pollination (caged during the whole blooming period) no set and yield can get at cultivars tested (*Table 5*). Even partial limitation of the bee pollination period can be fatal to the set at some cases. In most cases, however, partial limitation was not fatal to the yield. Caging in the first half of flowering (50% open second) gave more set and yield at three instances but the caging in the second half of flowering (50% open first) gave better figure at two occasions. Consequently no difference could be established in the sensitivity of quince against the limitation of the bee pollination period at the first and at the second half of blooming.

Apricot: Self-fertile apricot cultivars were tested. In spite of this no set was observed when bee pollination was totally excluded during the whole flowering period (*Table 6*). Even

Table 7 Yield of plum cultivars as affected by the effective duration of insect pollination (Ráckeve, Kecskemét, 1987, 1988)

Cultivar		Experiment (site and year)	Yield from 50 flowers (n=16) (total weight of fruits, g)				Significance difference (p<0.05)
			Free pollination (no caging)	Partial limitation		Total limitation (caged during the whole blooming period)	
				(caged from the 6th day of blooming)	(caged from the 4th day of blooming)		
Self-sterile cultivar	Cacanska najbolja	R-1987	32.8	36.1	0	0	1.57
		R-1988	31.9	33.2	0	0	4.28
Self-fertile cultivars	Cacanska lepotica	R-1987	27.1	27.4	29.9	27.1	1.27
		R-1988	30.0	33.7	33.8	28.9	4.94
	Cacanska rodna	R-1987	14.8	15.9	15.7	15.5	0.67
		R-1988	27.2	26.2	26.9	26.9	4.81
	Stanley	K-1987	21.4	23.3	25.1	23.0	–
		K-1988	27.9	29.8	29.2	30.3	–

Experimental sites: R= Ráckeve (Central Hungary)
K= Kecskemét (South-central Hungary)

partial limitation of bee pollination period (caging during the first or the second half of blooming) was resulted in no yield or at least significant reduction in yield. No difference can be established between the result of caging in the first and the second half of blooming even at the cases when one of the two kinds of caging was resulted in some yield.

Plum: Self-fertile and self-sterile plum cultivars were tested. Self-sterile plums behaved similarly to the limitation of the bee pollination period as self-sterile apples. They gave no set and yield when bees were totally excluded by caging (*Table 7-8: Cacanska najbolja, Tuleu Gras, Centenar, President*). Free pollination gave the highest set and yield at these cultivars and partial limitation of the bee pollination period was resulted in a much smaller set. The caging in the first half of the blooming period was not so unfavourable than the limitation of bee pollination in the second half of that. In the case of self-fertile plum cultivars the partial limitations of bee pollination period failed to cause any reduction of yield at most cases we studied (*Table 7: Cacanska lepotica, Cacanska rodny, Stenley*) but total limitation of the bee pollination period was resulted in a slight decrease of yield at some instances. At one another self-fertile cultivar the effect of the limitation of bee pollination period was much more remarkable on the fruit set and the yield (*Table 8: Debreceni muskotály*). Total limitation of the bee pollination gave a small yield in this case and even partial (50%) limitation of the bee pollination period caused a strong reduction.

Table 8 Fruit set and yield of plums as affected by the effective time of insect pollination (Cegléd, 1997)

Cultivars	Effective duration of insect pollination during the blooming period	Final set (per cent) (n=4)	No. of fruits for 100 flowers (n=4)
Tuleu Gras	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	0.5±0.5	8±8
	(3) 50 % open (second)	8.0±5.0	98±37
	(4) 100 % open	11.5±2.1	126±29
Centenar	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	0.5±0.5	8±8
	(3) 50 % open (second)	2.0±2.0	30±30
	(4) 100 % open	4±4	83±83
Debreceni muskotály	(1) 0 % open (caged)	1.0±0.6	25±14
	(2) 50 % open (first)	2.0±1.4	73±50
	(3) 50 % open (second)	2.5±1.9	58±38
	(4) 100 % open	6.5±2.2	128±39
President	(1) 0 % open (caged)	0	0
	(2) 50 % open (first)	2.5±0.5	100±16
	(3) 50 % open (second)	4.0±4.0	127±127
	(4) 100 % open	9.5±4.3	255±33

Explanation:
(1): 0 % open (caged) = caged during the whole blooming
(2): 50 % open (first) = open in the fist half, caged during the second half of blooming
(3): 50 % open (second) = caged in the first half, open during the second half of bloom
(4): 100 % open = no caging, open pollination

Sour cherry: Self-sterile and self fertile cultivars were investigated. The self-sterile sour cherry cultivar *(Pándy meggy)* was suffering of the lack of sufficient bee pollination very much because total limitation (caging during the whole blooming) gave no yield and also partial limitation of the bee pollination period was resulted in much smaller fruit set than open pollination (*Table 9*). In the case of self-fertile cultivars, however, the partial limitation of the bee pollination period failed to affect the fruit set but total exclusion of the bees decreased the fruit set drastically. The reduction was as much as some 2/3 (*Table 9*).

Discussion and conclusions

Changing weather and the lack of sufficient number of bee colonies at the nearby can greatly limit the duration of the effective bee pollination period in flowering fruit plantations. Results of our experiments prove that self-sterile fruits (apple, pear, quince, some plums and some sour-cherries) are greatly sensitive to the lack of bee pollination. This finding is in accordance with the world literature because the indispensable role of bee pollination is stressed for a long time for self-sterile fruit crops (*c.f. Free* 1970, 1993). However, the detrimental effect of partial reduction of the bee pollination period has not been emphasised so far. It was found that even partial reduction of the bee pollination

Table 9 Fruit set of sour cherry cultivars as affected by the effective duration on insect pollination (Kecskemét, 1988)

Cultivar		Yield from 50 flowers (n=16)				Significance difference (p<0.05)
		Free pollination (no caging)	Partial limitation		Total limitation (caged during the whole blooming period)	
			(caged from the 6th day of blooming)	(caged from the 4th day of blooming)		
Self-sterile cultivars	Pándy meggy	4.8	1.5	1.0	0	0.6
Self-fertile cultivars	Cigánymeggy	32.1	31.0	26.7	11.1	3.7
	Ujfehértói fürtös	31.4	32.1	32.3	10.0	5.8

period drastically decreases the fruit set and yield in the case of self-sterile fruit species and cultivars mentioned. Such a severe reduction of the fruit set for partial and total reduction of the bee pollination period was also observed in a self-sterile sweet cherry cultivar by *Roversi* and *Ughini* (1986). For this reason these crops should be provided with an intensive bee pollination during their whole flowering period. There are some indications in our experiments that the first half of the blooming may be more important for the yield formation than the second half of the blooming, however, there are some contradictory results in the experiments, too. Accordingly, this time we can not make a reliable difference between the first and the second half of blooming from the point of view of insect pollination.

In the case of self-fertile fruits the role of insects (bees) as pollinators is not so widely accepted in fruit growing circles. Therefore, our findings should be evaluated from this point of view. It was found that in the case of self-fertile apricots the effect of the total and also the influence of the partial limitation of bee pollination period was the same as in the case of self-sterile fruits. On the other hand, in the case of another self-fertile fruits (some plums, some sour cherries) the effect of partial limitation of the bee pollination period was usually small, but the complete (or incomplete but strong) limitation of that usually resulted in a significant reduction of yield. This findings corroborate to our earlier statement that not only self-sterile but also self-fertile fruits clearly depend on insect (bee) pollination and need intensive bee pollination during the blooming period as a whole (*Benedek* and *Nyéki* 1996). This is because pollen dehiscence of anthers and the receptive period of the stigmas do not overlap in time within the individual flowers. Stigmas in self-fertile trees, therefore, need pollen carried by bees from another flowers of the same tree (or compatible pollen from another trees).

There is a long dispute on the extent of self-sterility and self-fertility of a number of fruit species and cultivars in the literature because the same cultivar is often regarded to have different capacity of self-fertility in different experiments and under different environmental conditions (*Nyéki* 1996). However, the results reported here clearly show that additional bee pollination (moving bee colonies to the orchards in flower) is needed to all kinds of temperate-zone fruit tree species independent of their capacity to self-sterility when bee visitation of the plantations is not abundant enough for some reasons. It is also to be taken into account that fruit trees bloom very early in spring when not more than a few pioneer wild pollinators (some early season wild bees: overwintered bumble bee queens, early season Osmia and Andrena species) are on wing and their density can not reach a high figure because too much fruit trees start to bloom simultaneously in a small area within big plantations. For this reason sufficient insect pollination of fruit orchards can only be provided by moving honeybee colonies to the flowering fruit plantations.

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