

Developing fruits function too strongly as sink

Young fruits pull so hard, flowers above abort

Sweet peppers arrive in waves. New fruits lure so many assimilates towards them that the flowers above them abort. This article provides various suggestions about how to flatten out the peaks and troughs. In the long term, breeding can also play an important role.

Pepper production shows a clear fluctuation pattern. And not just per plant but across the entire nursery and even the whole sector. The normal pattern is: A few flowers set fruit; just above, a few flowers abort; above that setting occurs again. This wave pattern is a big problem and across many pepper nurseries these peaks and troughs occur simultaneously. Such fluctuations in total production have an effect on the weekly price.

Young fruits pull too hard

It's easy to explain why production occurs in waves but finding a solution is somewhat harder.

The problem arises because developing fruits have too strong a sink action. All organs in the plant act like a drain (or sink) and draw sugars towards them. However, the sinks don't have an equally strong pull.

The young fruits pull so hard, that there's hardly any sugars left over for the flowers above (*figure 1*). And so they abort. At a later point in the fruit's development it needs fewer assimilates and then the flowers have another opportunity.

Actually, sweet pepper is an usual plant; it continuously tips the balance. It immediately sets two to four fruits but this is too many. The problem can't be solved by supplying more heat, light or CO₂. As a result production increases but the wave pattern remains. Often the problem is greatest in the summer. Temperature control in the greenhouse can have some effect. Growers often reduce the temperature at the time of setting to obtain strong vigorous flowers. After that they increase the temperature again to stimulate their development. The latter reinforces the wave pattern.

Seeds intensify sink action

It's noteworthy that cucumbers don't demonstrate such an extreme wave pattern even though the strength of the sink from the fruits is much larger than that from peppers. This is for two reasons. Firstly, cucumbers hang on the plant for just three weeks, while

(red) peppers hang for eight weeks. Secondly, cucumbers don't have any seeds. Seeds produce auxins which intensify the sink action.

The role of the seeds was studied in a trial in which sweet pepper flowers were treated with an auxin paste. The paste prevented any pollination taking place and the auxin prevented any flower abortion. The result was a plant with evenly hanging seedless fruits (*see photo right*) which were smaller and less regular.

Different solutions

At nursery level, it would be useful if the peaks from half of the plants could compensate for the troughs from the other half. This can be achieved by having two planting dates. It works well by planting firstly in April and then in May, but this of course is not a very practical option. When planting in December and then in January the difference is clearly visible at the beginning but after just one dark week all the plants are at the same stage. In this period of the year there is simply too little light.

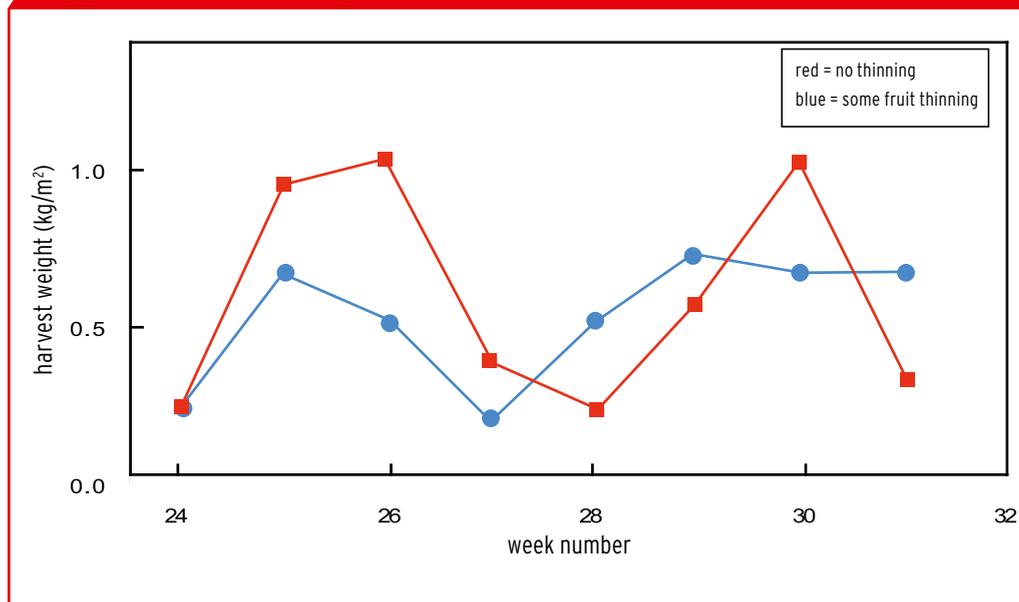
A second solution is to allow two or three settings to develop and after that remove all the flowers from half the crop for a period of three weeks. In this way half the plants are out of phase. This system has been tested and works well. However, it has several disadvantages. Removing flowers by hand requires a lot of work. Also the total production decreases. In addition the wave pattern becomes even greater and that can result in lower quality fruits, for example more buds and blossom end rot. A third option is to bring production out of phase by using temperature control.

Thinning out settings

Financially speaking, bringing the crop out of phase could be favourable if you can supply product when other growers are in the middle of a trough. Then a higher price can compensate for a lower production. But of course, there's no price guarantee.

Another option is to thin out all the settings to achieve a more regular cropping.

Figure 2. Effect of thinning out fruits on production



The peaks and troughs in production can be flattened out by thinning out the fruits. This trial was planted in April and the researchers tried to maintain two fruits per plant (one per stem).



Under normal circumstances peppers are produced in waves (left). In a trial in which the flowers were coated with the hormone auxin, fruit production was more even (right). This prevents flower abortion and the fruits develop without seeds.

This also works; the peaks and troughs do level off (figure 2). But again this has a drawback. The setting is not completely under control. In the unexpected event of a flower not setting when it was supposed to, you end up with fewer kilograms.

And a final option: Only release the bumblebees if the setting is looking difficult. Pollination by bumblebees produces more seeds which creates a larger sink action. Theoretically, this should work.

Parthenocarpy varieties

The difficulty with this entire problem is fundamentally; the total setting can't be increased. Far fewer assimilates reach the fruits on a pepper than on a tomato or

cucumber. This is 65% of the assimilates in a pepper and more than 70% for the other two fruit vegetables. There's no technical reason to explain it. For example, the pepper plant has enough leaves, which compared to tomato also remain in good condition for a long time. So the plant doesn't need to make any extra investment here. Admittedly, the stem is stronger but this can't account for the difference completely. It's a difficult point to solve.

The seeds do offer a few clues. Even without seeds, a wave pattern would appear in the production, but they do reinforce it. If there were no seeds in the fruit, the effect would be less evident. Setting would be more regular. However, the fruits would be smaller. Parthenocarpy varieties don't exist yet, that's

to say: fruits that can set without pollen and therefore don't contain any seeds. This is a route to investigate further. For consumers too, seedless peppers will be attractive.

Even between varieties there are differences in the degree of wave pattern. Research by Wageningen UR Greenhouse Horticulture shows that varieties with smaller fruits have a more regular setting and steadier harvest than varieties with a higher average fruit weight.

Summary

Young pepper fruits have such a strong draw on assimilates that the flowers above abort. This results in a wave pattern in production. One solution would be to bring half of the plants out of phase, so that they compensate for the peaks and troughs in the other half. The seeds intensify the wave pattern but up to now there are no parthenocarpy (without seeds) varieties.

Figure 1. Influence of seed number on the setting.

Pollination of fruit 1	Setting of fruit 1 depending on method of pollination	Number of seeds in fruit 1	Setting of fruit 2
Hardly any pollination	23 %	5	65 %
Limited pollination	68 %	54	42 %
Manual pollination	71 %	251	20 %

The effect of number of seeds in fruit on the setting potential of the next fruit (2 nodes higher). The more seeds in fruit 1, the lower the chance of the next fruit setting.