

Tomato pollination and how to increase it in high tunnels



Gerald Brust
IPM Vegetable
Specialist

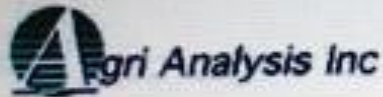
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I have been growing HT tomatoes for the last 10 or so years in the mid-Atlantic and have always thought my tomatoes did pretty well. Until I saw a report about the average yield per plant.....



Research in the eastern United States has demonstrated that the yield per plant from a HT tomato should be between 20 and 30 lbs per plant.

My yields averaged 19.6 lbs/plant



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A great number of my studies looked at the fertilization of tomato plants in HTs so I kept a close eye on the plants with soil and tissue tests like the one you see here. All the tests showed my fertilization program was good.

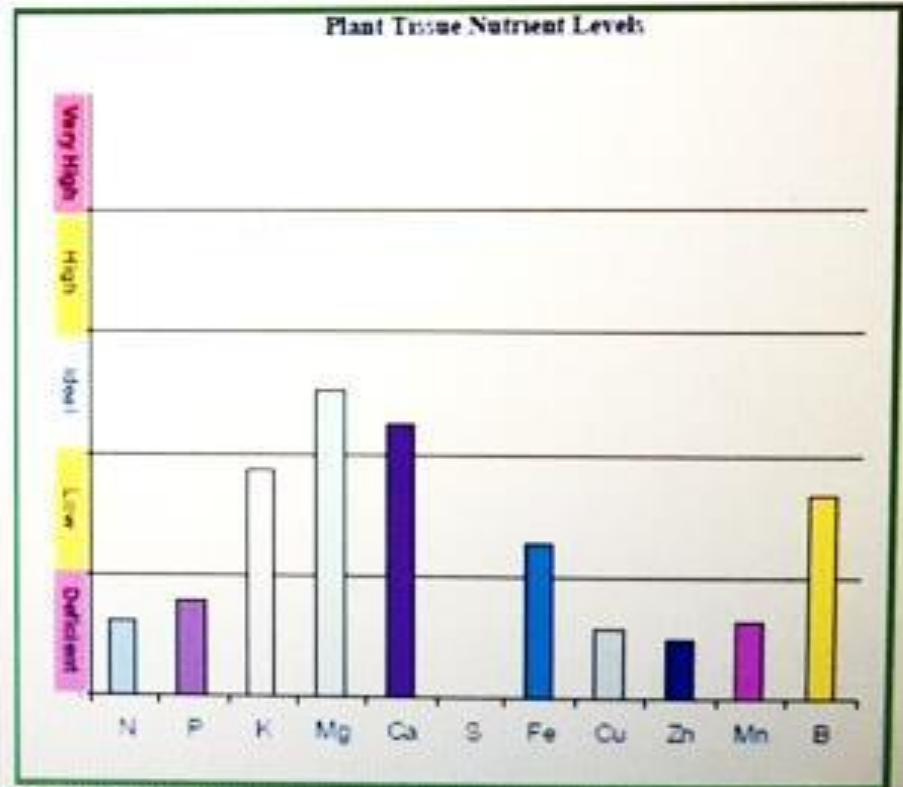
PLANT TISSUE NUTRIENT REPORT

Customer: Gerald Brust
 2005 Largo Road
 Upper Marlboro, MD 20774
 Grower: Gerald Brust
 Submitted by: Gerald Brust
 Salesmen:

Sampled Date: 6/22/2014
 Received Date: 6/23/2014
 Reported Date: 6/24/2014

Lab number: P2884
 Crop code: 223
 Sample ID: Wye
 Growth Stage: Tomato petiole-mid bloom 3rd cluster

<i>PLANT NUTRIENT ANALYSIS BY REFERENCE METHOD</i>			
<i>PERCENT (%)</i>	Dry Basis Results	Sufficiency Ranges	
		Low	High
Nitrogen	1.85 %	3.00	4.00
Phosphorus	0.31 %	0.40	1.00
Potassium	5.23 %	5.00	9.00
Magnesium	0.55 %	0.30	0.50
Calcium	1.74 %	1.50	2.40
Sulfur	0.35 %		
<i>PARTS PER MILLION</i>			
Iron	91.71 ppm	60.00	300.00
Copper	6.31 ppm	5.00	50.00
Zinc	26.29 ppm	20.00	250.00
Manganese	31.18 ppm	50.00	250.00
Boron	33.24 ppm	25.00	75.00
Sodium	1,890.62 ppm		
Aluminum	78.04 ppm		
Molybdenum			



Note: All values Derived from "TOTAL Plant Analysis"



So what else could be causing a reduction in my yields? One thing I noticed in my HT was about 50-60% of my flowers-potential fruit-did not make it to fruit. As you see here on 3 clusters of tomato only 6 out of a possible 15 flowers turned into fruit. The flowers you still see on these clusters will abort.....

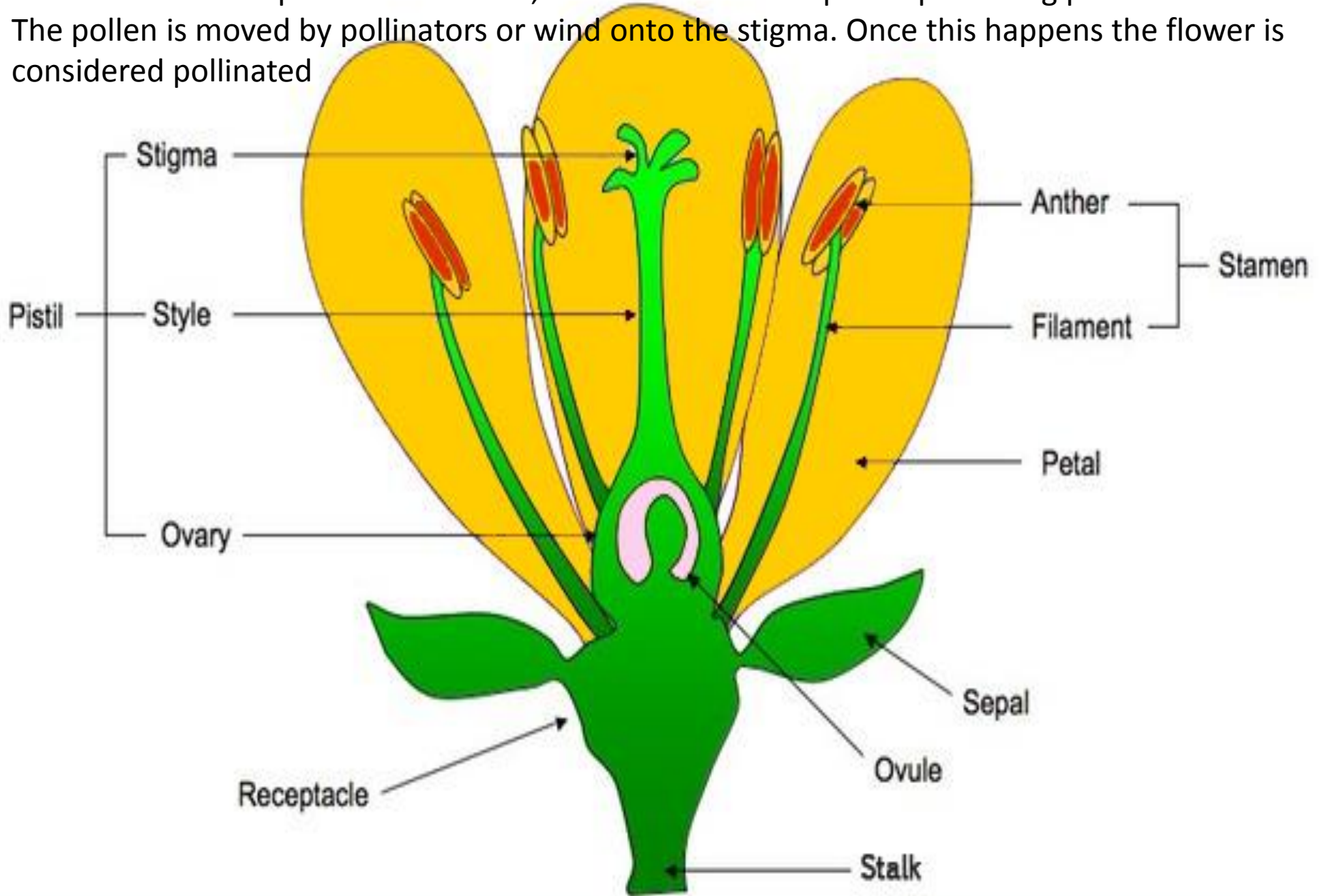
These clusters had all their flowers abort - this is due to poor pollination, poor fertilization or both



Tomato flowers are unusual among vegetable flowers. They have yellow petals and a yellow funnel-like structure coming out of the center of the flower. Most think this structure is made up of petals, but it is not—these are anthers

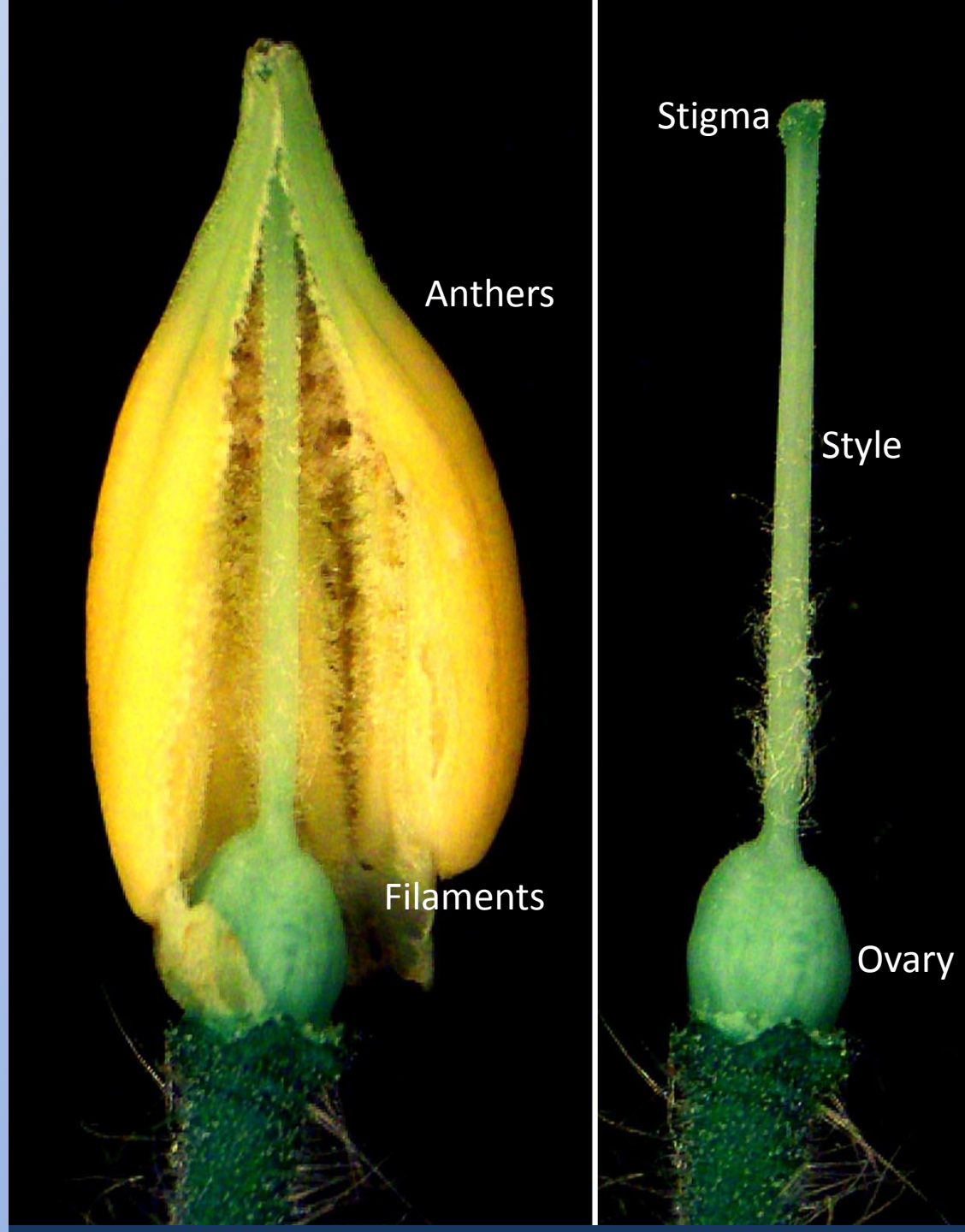


This is an idealized picture of a flower, the anthers are the pollen producing part of the flower. The pollen is moved by pollinators or wind onto the stigma. Once this happens the flower is considered pollinated

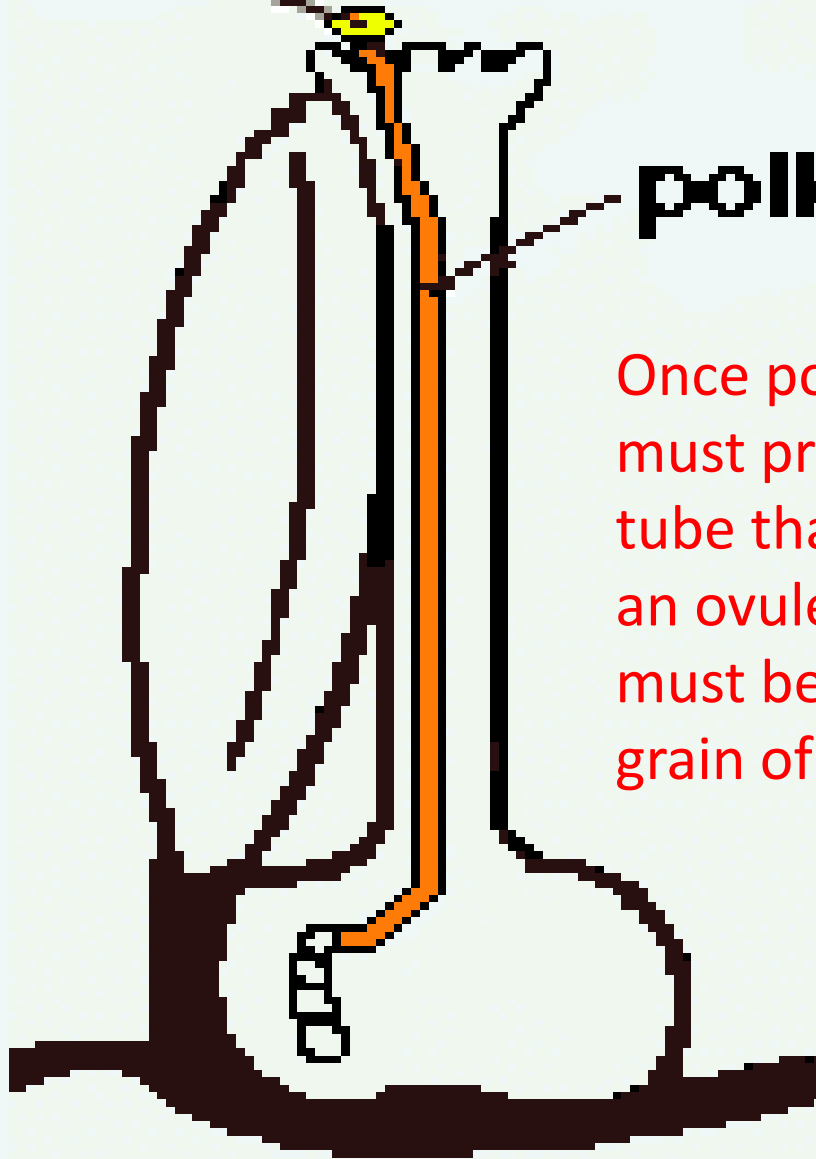


Parts of a flower

In tomato flowers the anthers surround the female part of the flower and just about any pollen that falls on the stigma comes from the same flower (and therefore plant—there is no or little cross-pollination in tomatoes). Tomato pollen is sticky and fairly heavy as pollen grains go and it takes a good breeze or a vibration of the flower to dislodge the pollen from the anthers onto the stigma.



pollen grain



pollen tube

Once pollinated, pollen must produce a pollen tube that delivers sperm to an ovule (seed). Each seed must be fertilized by a grain of pollen.

The final size and weight of fruit are largely determined by the number of seeds set, which is ultimately due to the quality of pollination and fertilization

Temperatures above 88°F may cause abnormal style elongation. High rain fall will cause pollen to clump and be less available for pollination.

The optimum temperature for pollen tube growth is 70°F. Above or below this temperature reduces the germination and growth of the pollen tube.

Temperatures above 90°F negatively affect the viability of ovules and pollen.

Bumble bees are good at pollinating tomato flowers. When they grab onto the flower with their mouth parts and vibrate the flower they remove some of the pollen from the flower. By doing this they also vibrate loose pollen that falls onto the stigma and helps pollinate the flower very efficaciously.



collected pollen



This flower has not been visited by any bumble bees as it has no markings from where the bee hung onto the flower with its mouthparts



This flower has been visited by several bumble bees. The brown marks on the flower show where the bees grabbed onto the flower anthers

After many visits and grabbing of flowers the flowers become pollinated and fertilized and the petals start to fall off. The brown ends of the tips of the anthers signal that the flowers were heavily visited by bumble bees. This can be looked for in a HT or out in the field to see how well your flowers may be visited and pollinated. Bumble bees are the best at doing this type of pollination—called 'buzz pollination'. In greenhouse tomato production they use tiny vibrators to pollinate tomato flowers and this is called sonication



Enhanced Pollination Study

The study was conducted for 2 years. The first year of the study only one HT was used while in the 2nd year 2 HTs were used. One HT was on the eastern shore while the other was on the western shore.

Four different cultivars of tomatoes were used in both HTs, 2 hybrids (*Mt Fresh+* and *Crista*) and 2 heirlooms (*Cherokee Purple* and *Brandywine*).

I used a Craftsman 235/150 mph electric blower to sonicate (buzz pollinate).



Leaf blower
used in
enhanced
pollination
study

An 'enhanced pollination treatment' consisted of taking the leaf blower and placing it on low (150 mph) with the end of the blower 2-3 ft from a plant moving it back and forth and up and down concentrating the movement in the area of the flowers.

Plants were treated either 0, 2, or 4+ times a week and for either 0, 5, 10, or 20 seconds per plant with the blower. Treatments started 5-days after the first flower cluster appeared and were treated for 4 weeks. There were 4 replications of each treatment, 5 plants per rep.

One concern I had about the technique is that if fruit set was increased and plants were supporting more fruit:

1. Would plants be able to size those tomatoes and
2. Would the tomatoes have good quality?

Results



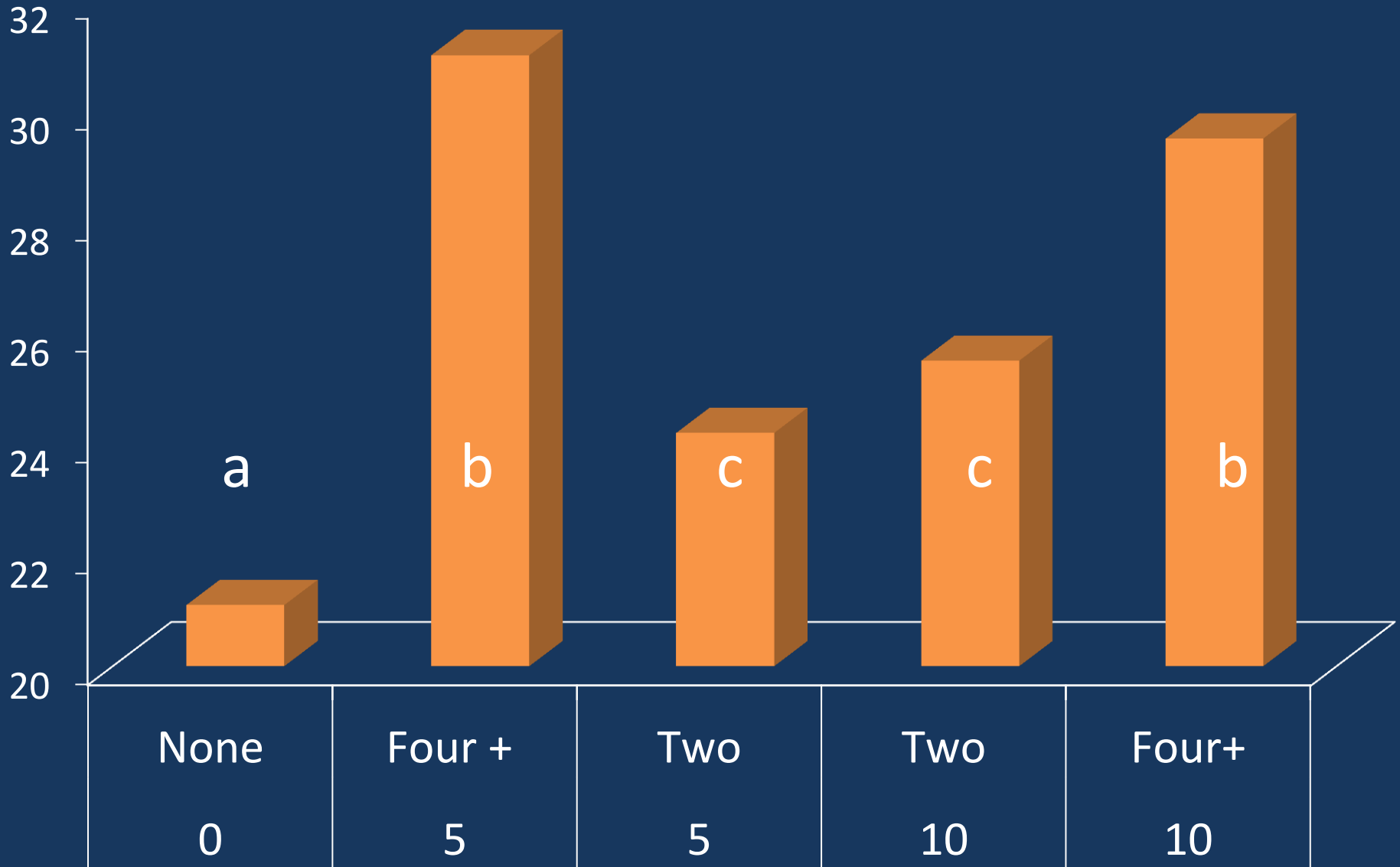
Typical untreated area with only half of flowers pollinated

Two clusters of tomato flowers with a potential 12 flowers, had a total of 10 fruit produced. Only 1 fruit (arrow) did not size correctly on these two clusters—treated for 5 seconds 4 days a week.



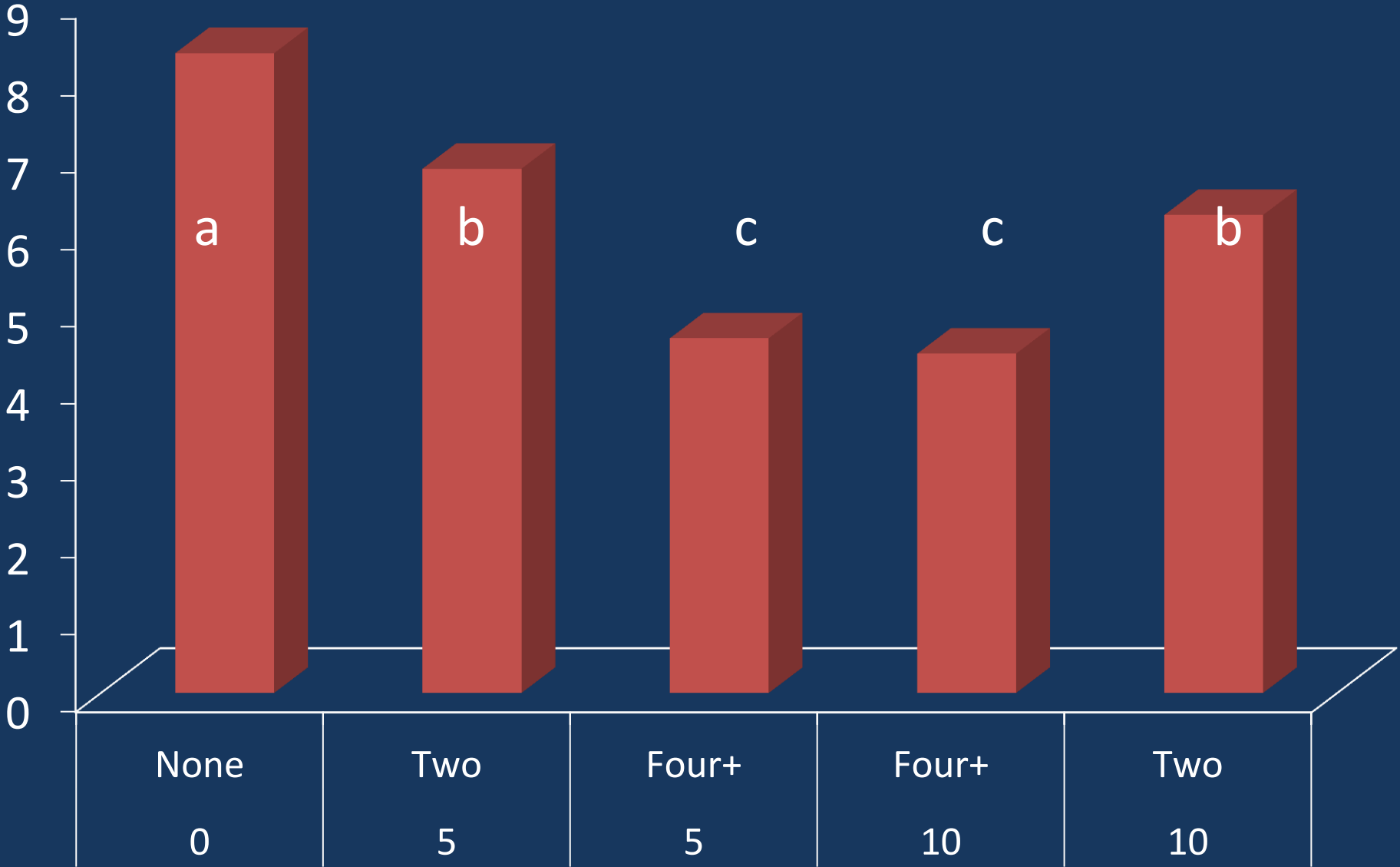
Yield (lbs)

1st harvest/plot



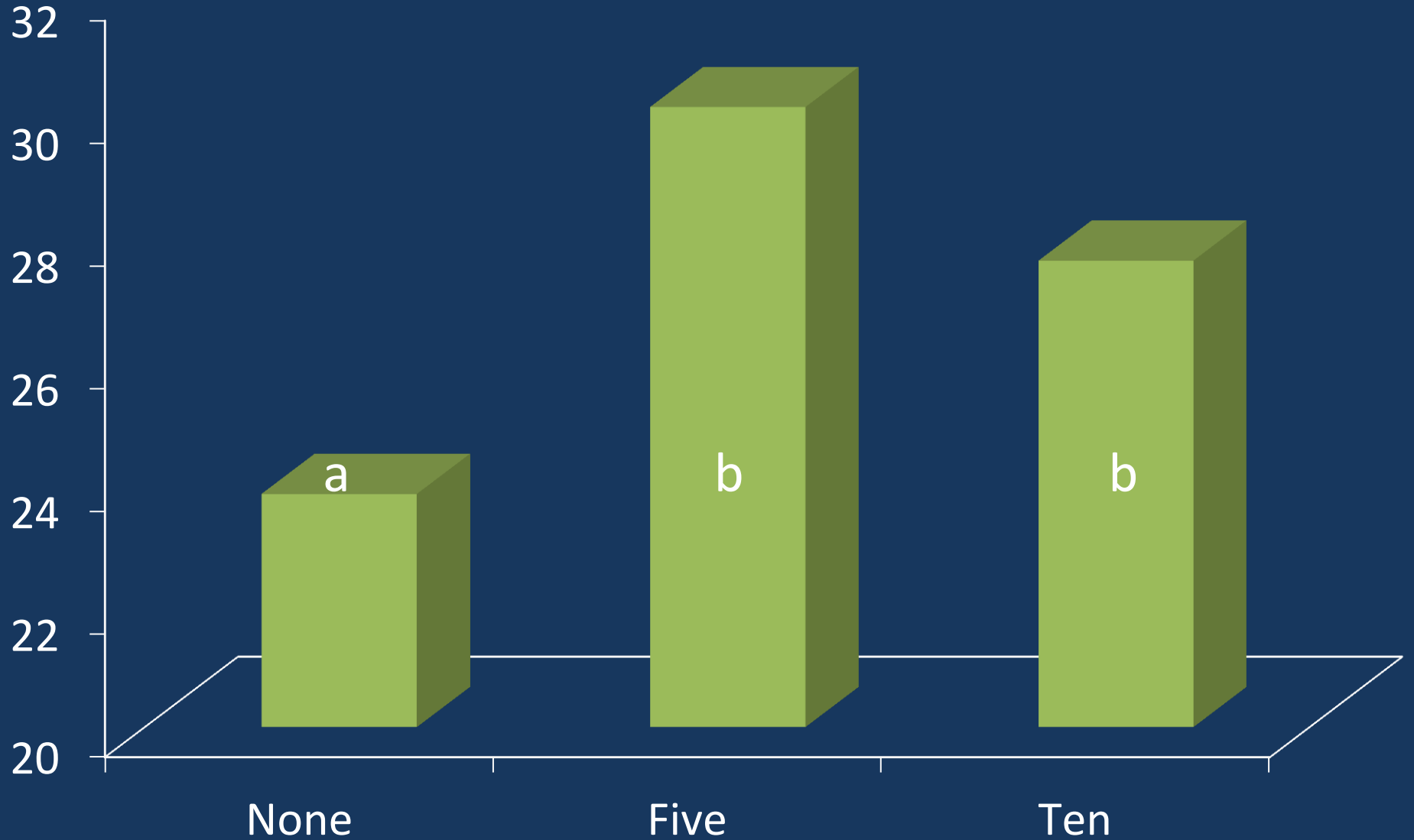
Culls (lbs.)

1st harvest/plot



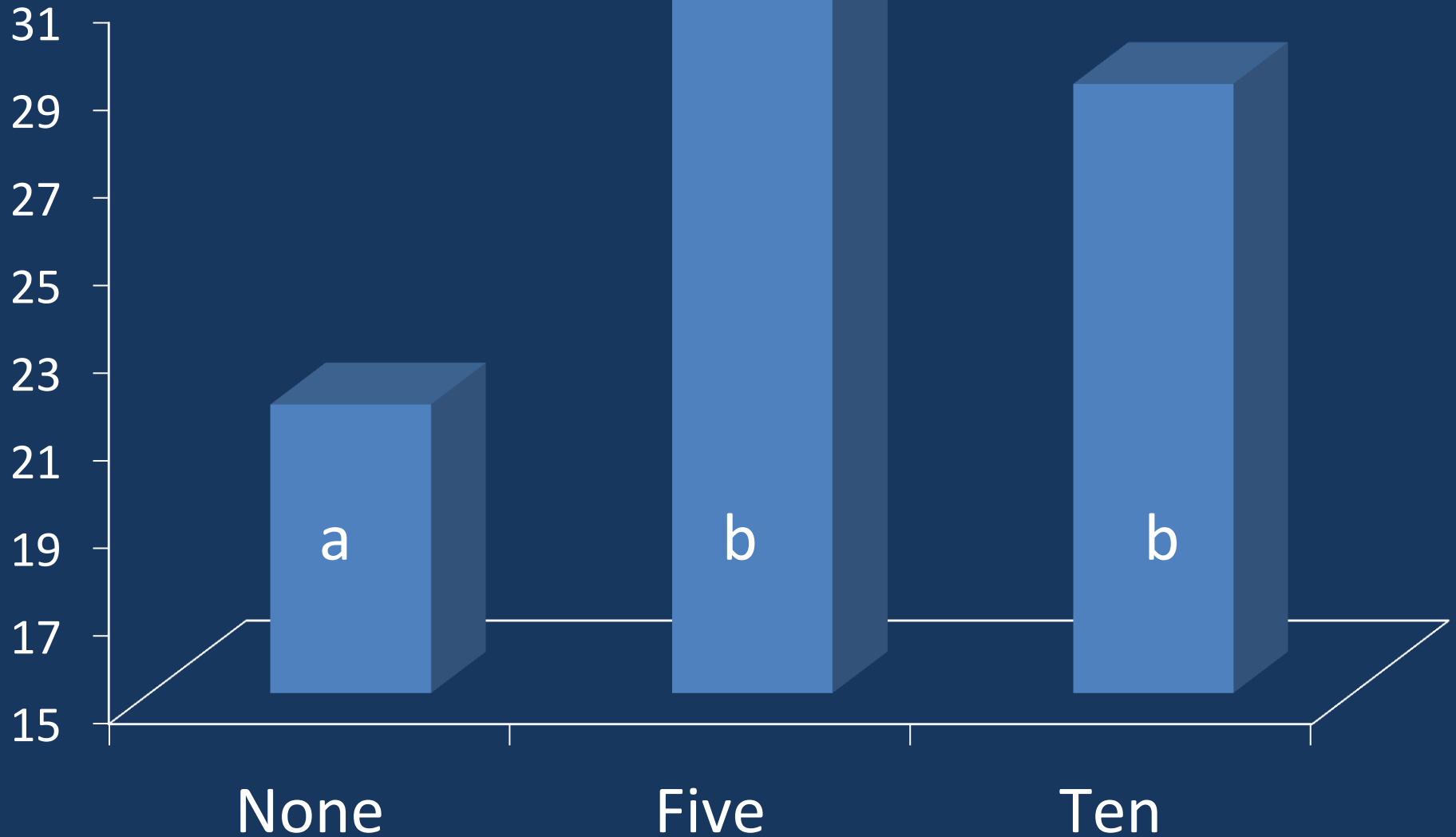
Length of time pollination enhancement occurred

Yield (lbs)
1st harvest/plot



Yield (lbs) of total harvest

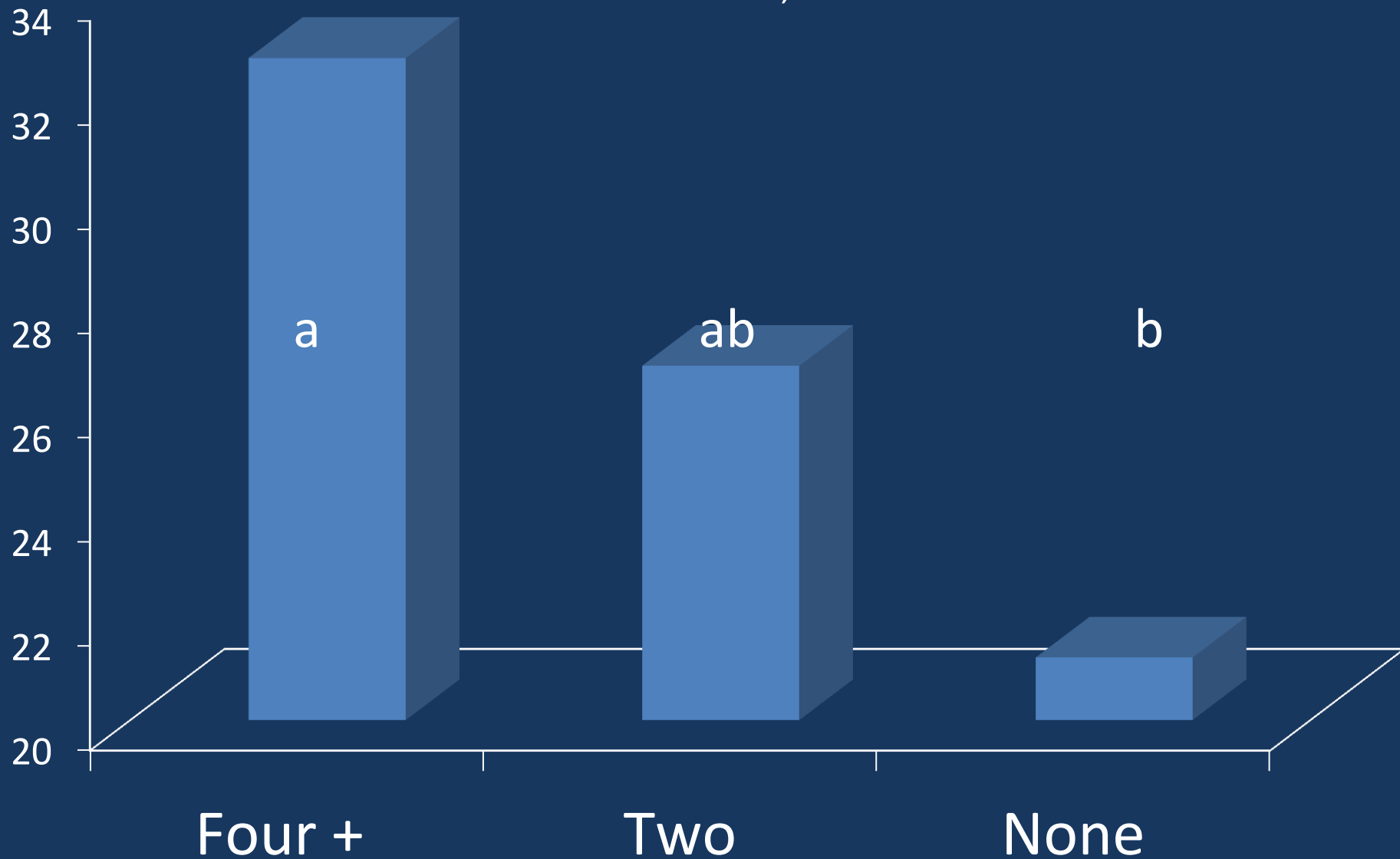
Per plant



Frequency of pollination enhancement per week

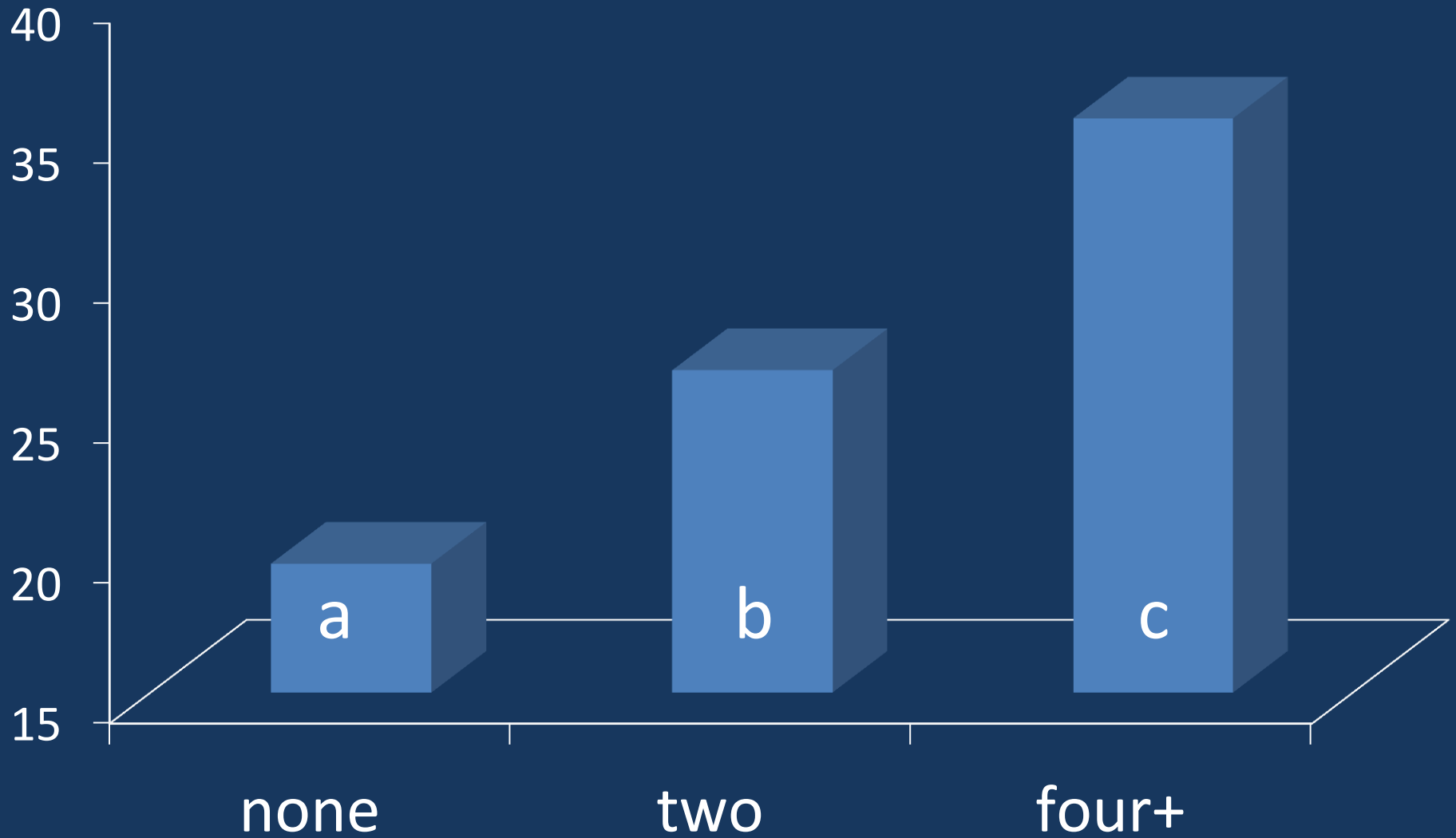
Yield (lbs) per plant

total harvest, HT-A

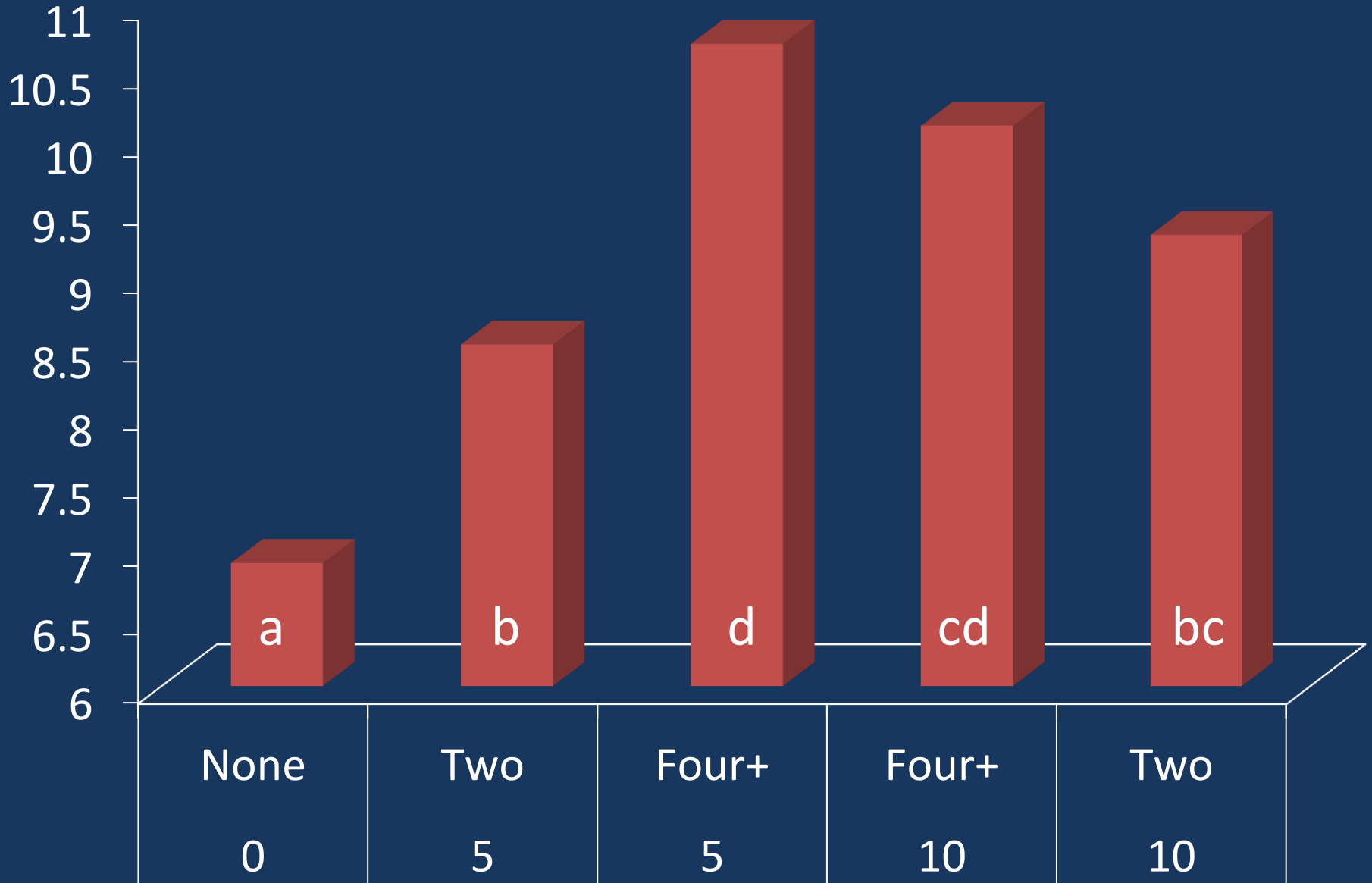


Wt (lbs) per plant

total harvest, HT-B



Mean Weight (oz.) of 1 fruit



The image shows two yellow plastic crates filled with harvested tomatoes. The crate on the left contains tomatoes that are uniformly bright red and appear healthy. The crate on the right contains a mix of red and yellowish-green tomatoes, indicating some are not fully ripe or have been affected by a condition. The crates are placed on a dark, textured surface, possibly soil or mulch, with some green foliage visible in the background.

Treated for 5 seconds 4
times per week- 5 plants

Not treated—5 control plants

Overall yields were good in these two HTs compared with previous seasons. Normally I would have expected 19.6 lbs/plant in these HTs, but instead got 21.8 lbs per control plant.

The average yield per plant increased to as much as 33.7 lbs with the pollination enhancement technique.

By enhancing pollination I was able to increase my overall yields by as much as 55%.

The pollination enhancement technique also improved fruit quality by reducing the percentage of culls and increasing the average size of fruit.

One concern I had about the technique is that if fruit set was increased and plants were supporting more fruit:

1. Would plants be able to size those tomatoes and
2. Would the tomatoes have good quality?

The answer appears to be yes to both questions. We did not add any extra nutrients to either HT compared with how we normally fertilize.

This technique did appear to work better on the first 6-8 fruit clusters the plant produced vs using the technique on later fruit clusters.

This technique is not for everyone, but it could be utilized very easily in a HT and be carried out by just about anyone who can hold and point a leaf blower.

The plants would need to be treated for 5-10 seconds at least 4 times a week for there to be a good possibility of yield and quality enhancement.

Treating the plants longer than 20 seconds ended up decreasing yields compared with doing nothing (data from year 1).

Plants could undergo this enhancement technique in the early part of the season when the HT sides are often down.

CAUTION

This technique should not be used if your HT tomatoes are usually low in any nutrient at the first harvest or you have fruit ripening problems with later harvests. Heirloom cultivars responded less consistently than hybrid cultivars



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Questions

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