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Bitter Pit in Apple: A Calcium Disorder Being Mistaken for Disease in Kinnaur's Orchards

*Arun Kumar, Durga Peashad Bhandhari and Deepika
Scientist, Regional Horticultural Research & Training Station,
Sharbo and KVK, Kinnaur, Himachal Pradesh, India
*Corresponding Author's email: arunkumar.negi@gmail.com

Every apple season now brings the same complaint from growers across Kinnaur, and increasingly from Shimla, Kullu and other hill orchards as well: fruit that looked perfectly healthy on the tree develops small sunken, brownish depressions once it is graded, packed or taken out of cold store. Many farmers assume this is a fungal infection and reach straight for a fungicide spray. In most such cases, the real culprit is not a fungus at all. It is bitter pit, a physiological disorder of the fruit linked to a local shortage of calcium, and no amount of fungicide will fix it. Bitter pit has been recognised in apple-growing regions of the world for more than a century, yet it remains one of the most misdiagnosed problems in the orchard, simply because the brown, pitted flesh it leaves behind looks, at first glance, like rot. This article sets out what bitter pit is, how to tell it apart from fungal spotting and rots, why it appears to be increasing in Kinnaur's orchards, and the field-tested steps that can bring it under control.

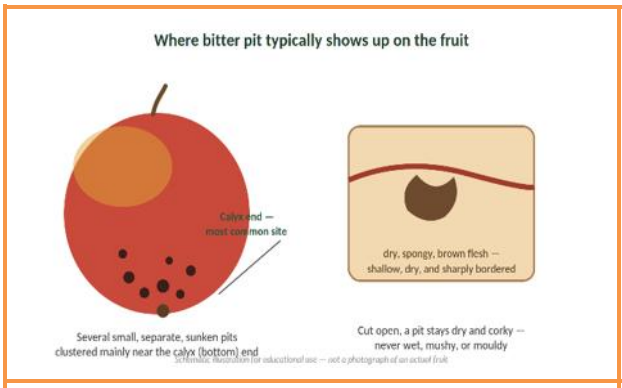
What exactly is bitter pit

Bitter pit is not caused by any insect, fungus or bacterium. It develops when the fruit tissue, particularly near the calyx (bottom) end, does not receive enough calcium during its growth. Calcium is essential for holding plant cell walls and membranes together. When a patch of fruit tissue runs short of it, the cells there begin to break down, leaving small, dry, sunken, dark-brown to purplish pits, usually one to ten millimetres across. Cut the fruit open and the flesh below the pit is dry, spongy and brown, not wet or mushy, and despite the name it is not actually bitter to taste in most cases; the name comes from the corky, unpleasant texture rather than flavour. The disorder can begin developing on the tree well before harvest, but the pits have traditionally become visible only after harvest, typically within the first four to eight weeks in cold storage. In recent seasons, however, symptoms are being seen more prominently even earlier, showing up as the fruit matures and colour development begins, while it is still on the tree. This is exactly when growers in Kinnaur are already anxious about two things at once: fruit slipping into B and C grade and fetching a lower price at grading, and the usual worry over storage rots.

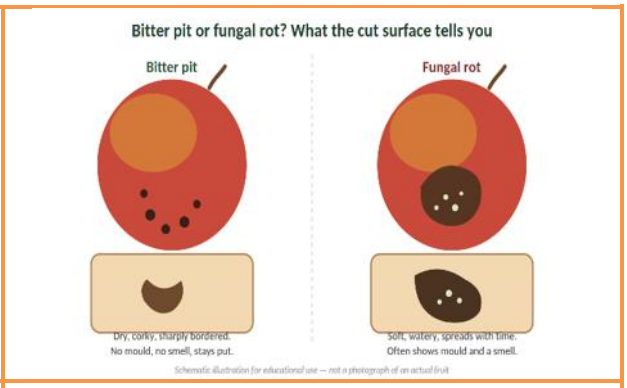
A reference-style photograph showing several separate dark, sunken pits grouped on one side of the fruit rather than spread over the whole surface

How to tell bitter pit apart from fungal disease: the field check

Because the visual mistake is so common and so costly, spraying fungicide will not touch bitter pit, and a bitter-pit lot wrongly treated as diseased can be needlessly rejected or dumped, a quick comparison in the packing shed is worth doing before deciding on any treatment.



Bitter pit's tell-tale pattern: several small, separate, sunken pits grouped mainly near the calyx (bottom) end of the fruit, staying dry and corky when cut open.



Bitter pit next to fungal rot, side by side. Bitter pit stays dry, corky and confined; fungal rot turns soft and watery, spreads with time, and often carries visible mould.

Feature	Bitter pit (calcium disorder)	Fungal spot / rot (e.g. Alternaria, Marssonina, storage rots)
Cause	Localised calcium shortage in the fruit tissue; not caused by any organism	Living fungus or bacterium infecting the fruit
Where spots appear	Mostly near the calyx (bottom, flower) end of the fruit	Anywhere on the fruit, often starting at wounds, lenticels or the stalk end
Depth of the lesion	Shallow, dry, sunken pits; flesh underneath is brown, dry and slightly corky, never soft or watery	Often soft, watery or sunken with a moist or mushy centre as decay spreads
Growth of the spot	Stays roughly the same size once formed; does not enlarge day by day	Enlarges visibly over a few days, especially in storage
Fungal growth / mould	None, no mycelium, spores or powdery growth on or in the pit	Often visible as fuzzy, powdery or velvety growth, sometimes with a distinct colour or smell
Spread from fruit to fruit	Never spreads between fruits in the box or in storage	Can spread to touching fruit, especially in humid or poorly ventilated storage
Response to fungicide	No response, spraying fungicide after symptoms appear does not help	Preventive fungicide sprays reduce incidence when timed correctly
When it shows up	On the tree before harvest, or within the first four to eight weeks of storage	Any time, but rot usually appears once fruit is wounded, over-mature or stored too long or too warm

A simple rule of thumb for the packing shed: cut a few affected fruits in half. If the brown area under the skin is dry, firm-edged and confined to a shallow zone with no smell and no visible mould, it is almost certainly bitter pit. If the tissue is soft, watery, discoloured beyond a sharp margin, or shows fungal growth or a foul smell, disease or storage rot is the more likely cause and needs a different response altogether.

Numerous small, roughly circular, sunken purple-to-black spots clustered on one shoulder of the fruit, with no fungal growth visible and the skin left blotchy rather than evenly coloured around them.

A second look-alike: pitting from calcium versus pitting from boron

Even after a grower has ruled out fungal disease, there is a second, quieter confusion worth knowing about. Pitting on apple can come from a shortage of calcium (true bitter pit) or from a shortage of boron, and the two are managed somewhat differently, so it helps to know which one is in play. The Himachal Pradesh Horticulture Development Project's manual on nutrient management, prepared for orchards of this state, sets out a useful rule: pitting that shows up late in the season, near harvest or in store, is almost always calcium-related bitter pit, while pitting seen early in the season is more likely to trace back to boron. Boron shortage on the tree usually shows itself in other ways too, die-back of the growing shoot tips and an upward curling of leaf margins, which calcium-related bitter pit does not cause.

Clue	Points to calcium (bitter pit)	Points to boron shortage
Timing of pitting	Pits show up late in the season, close to harvest, or after some weeks in store	Pitting is seen early in the season, well before harvest
What else to look for on the tree	Usually no other tree symptoms; problem is confined to the fruit	Die-back of shoot tips and an upward curling or rolling of leaf margins are often seen alongside the fruit symptoms
Which trees are worst affected	Lightly cropped, vigorously growing trees, and unusually large fruit	Can occur even on trees with a normal crop; often patchy across the block, following soil boron levels

The two nutrients are connected in any case: adequate boron in the tree improves how well calcium is taken up and moved into the fruit, so correcting a boron shortfall (through soil or foliar application, as recommended for the orchard's soil test) often helps the calcium programme work better rather than being a separate problem to solve on its own.

The cut test to check the bitter pit

Why Kinnaur's orchards are seeing more of it

Bitter pit is not new, but several features of apple growing in Kinnaur's dry temperate belt make orchards here particularly prone to it, and several recent trends are adding to the risk:

- Uneven or limited irrigation: In much of Kinnaur, orchards depend on channel irrigation or limited water sources, and long dry spells between waterings are common. Calcium travels into the fruit only through the water stream (the xylem), so any check in water supply during May–July directly reduces the calcium reaching the fruit, even where soil calcium is adequate.
- Heavy pruning and high nitrogen use: Hard winter pruning and generous urea or DAP application pushes the tree into vigorous shoot growth. Vigorous shoots draw calcium away from the developing fruit toward the leaves, leaving the fruit calcium-starved even on well-fertilised trees.
- Light crop load and oversized fruit: In years with poor pollination, frost damage at bloom, or excessive fruit thinning, the fewer fruits left on the tree grow unusually large. Bigger fruits need more calcium to serve the same volume of tissue, and bitter pit is consistently worse in outsized fruit.
- High-density and young orchards: Many high-density and ultra-high-density plantings coming up on clonal rootstocks in Kinnaur are still young, with strong vegetative vigour before they settle into regular bearing, precisely the growth pattern that predisposes to bitter pit.
- Potassium-heavy fertilisation: Potassium and calcium compete for uptake by the tree. Orchards that rely heavily on potash-based fertilisers or foliar sprays without a matching calcium programme often see fruit with a high potassium-to-calcium ratio, which is one of the most reliable warning signs of bitter pit risk.

- Early or delayed harvesting: Fruit picked well before or well after the correct maturity window tends to be more susceptible; and any delay in shifting harvested fruit into cold storage allows symptoms that were already developing to show up faster.
- Cultivar sensitivity: Among cultivars grown in the region, spur types and some of the newer high-colour and club varieties tend to show bitter pit more readily than the older Royal Delicious strains, so orchards that have diversified into these varieties may see the problem for the first time.

Managing bitter pit: what actually works

1. Orchard practices, the first line of defence

- Prune moderately rather than heavily; avoid a single hard cut-back that triggers a flush of vegetative growth.
- Maintain a steady crop load through timely, moderate thinning rather than very early or very heavy thinning, which tends to increase fruit size and bitter pit risk.
- Keep soil moisture even through the fruit development period, especially May to July; where irrigation is limited, prioritise water during this window over later stages of fruit growth.
- Go easy on nitrogen once fruit set is complete; split nitrogen doses and avoid late-season urea application.
- Where soil or leaf testing shows a high potassium or magnesium level relative to calcium, correct the balance rather than adding more potash.
- Where a soil test shows a genuine calcium shortfall, correct it through the soil as well: lime on acidic soils, or, if the soil pH is already in the ideal range of about 5.8 to 6.5, gypsum instead, gypsum supplies calcium without pushing the pH up any further.
- Pick fruit at the correct maturity stage for the cultivar and market; neither too early nor too late.

2. Calcium spray programme

Calcium reaches the fruit only through the water stream moving up from the roots, and this uptake happens quickly in the first weeks after fruit set, but only until the fruit reaches about walnut size, roughly 25 mm across. After that, the fruit keeps growing and the calcium already inside it gets diluted faster than the roots can replace it. This is exactly why calcium deficiency shows up in the fruit and almost nowhere else on the tree, and why foliar and fruit-surface calcium sprays become the main tool for keeping fruit calcium up once expansion begins, soil calcium is important, but it alone rarely reaches the fruit fast enough on its own.

The standard recommendation: as per the Package of Practices for Fruit Crops issued by the Directorate of Extension Education, Dr Y.S. Parmar University of Horticulture and Forestry (YSPUHF), Nauni, Solan, the recommendation for apple orchards is straightforward:

Chemical used	Quantity per 200 litres of water	Number of sprays, interval, and timing
Calcium chloride	1 kilogram	One to two sprays at a 15-day interval; the first spray to be given 45 days before picking

This is the recommendation growers should follow as the baseline, since it comes from the university's own package of practices for the state.

A more detailed, season-long option: for orchards with a stronger bitter pit history, or where a grower wants to spread the same total calcium over more, lighter sprays rather than one or two heavier ones, the calcium-management guidance set out in the Himachal Pradesh Horticulture Development Project's Manual on Nutrient Management (World Bank funded) gives a more elaborate season-long schedule, reproduced below. This is a separate, additional recommendation from a different publication, not part of the university's package of practices, and growers should treat it as an alternative programme to choose from rather than an addition on top of the university schedule.

Timing	Material and rate	Remarks
From the walnut-sized fruit stage (about 25 mm diameter, roughly six weeks after fruit set) onward	Calcium chloride, 360–500 g per 100 litres of water; use the higher rate in orchards with a known bitter pit history	Give 6–8 sprays across the season; in deficient orchards, aim to put down at least 2.5 g of calcium per square metre of orchard ground area over the whole season
The first two sprays, if fruit marking/spotting is already a concern	Substitute calcium nitrate at 600 g per 100 litres in place of calcium chloride	Calcium nitrate is gentler on young fruit skin than calcium chloride at this early stage
Early sprays, on young or tender foliage	Half-strength calcium chloride, applied twice instead of one full-strength spray	This protects tender leaves while still delivering the full seasonal calcium total
Right through to as close to picking as practical	Continue the same calcium chloride schedule	Late-season sprays raise fruit calcium at harvest more effectively than early ones, so do not stop the programme too soon
At harvest / packing	Postharvest calcium chloride dip, about 2–4%, for one to two minutes	Especially useful for fruit going into cold storage; wash the fruit again before dispatch to remove the salt residue

A caution on rates, which applies to either programme: calcium chloride sprayed too strong, or applied when temperatures are above about 24°C or drying conditions are extreme (either very fast or very slow drying), can scorch leaves and cause fruit russeting. Add a surfactant or spreader if the spray is not already being tank-mixed with another compatible product, check compatibility before mixing calcium with any other chemical, and aim for thorough coverage of the fruit surface rather than a hurried pass, coverage matters as much as concentration.

Postharvest and storage handling

- Cool fruit as soon as possible after harvest; delayed cooling allows any incipient bitter pit to develop and worsen.
- Where a postharvest calcium dip is used, wash the fruit again afterward to remove the salt residue before packing.
- Store bitter-pit-prone lots for a shorter period, and inspect a sample from each lot after four to six weeks in store before committing the rest to long-term storage.
- Keep bitter-pit-affected fruit separate from healthy fruit in grading; unlike fungal rot, bitter pit will not spread to sound fruit, but mixed lots lose market value and buyer confidence together.

Bitter pit in apple is a calcium-related physiological disorder, not a fungal disease. In Kinnaur, its incidence can be reduced through balanced nutrition, adequate irrigation, appropriate crop load and timely calcium sprays. Correct diagnosis is essential to avoid unnecessary fungicide applications and minimise postharvest losses.