TESSENDERLO Kerley

STONE FRUITS

In botany, a stone fruit is produced by flowering plants in the subfamily *Prunoideae* of the family *Rosaceae*. The most well-known stone fruits are apricot, cherry, plum, peach and nectarine. Peach and nectarine represent the largest production, followed by plums. Peaches originated from China, where manuscripts dating back to 1100 BC mention the production of this fruit. Stone fruit require a cold winter in order to produce fruits. Peaches and nectarines are the least cold demanding and can also be grown in the subtropics.

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APRICOT

Most apricot trees begin to bear fruit in their second or third year but substantial bearing does not begin until the fourth or fifth years. Typically, orchards will have their first commercial harvest during the third or fourth year. Most apricot varieties require adequate winter chilling. Apricots are originally a Mediterranean crop and thus require a warm, dry growing season. Apricots will produce higher yields and achieve better size fruits on deep, well-drained soils. They do not tolerate high levels of salts and soil analysis can give valuable clues to potential problems. The correction of soil problems prior to planting is more effective than trying to correct these problems after establishment of the orchard.

Apricot orchards require a substantial amount of water for optimal production and fruit size. Irrigation should be designed to distribute water uniformly and efficiently to each tree. Depending on tree vigor and target yield, apricots are generally fertilized with low rates of nitrogen applied during the growing season. In sandy soils, apricots can potentially become potassium deficient. Leaf analysis is recommended to obtain valuable information about the nutrient status of the trees. Based on results of the analysis, recommendations about fertilizer can be made. For apricot production, profitability depends on the grower's ability to optimize fruit yield, quality and size. A combination of pruning and fruit thinning is the best means of optimizing the crop.

The selection and propagation of rootstocks for apricot is also an important consideration that varies depending on the local climate, soils and cultivars. Rootstocks vary in their responses to environmental and biotic stresses and a range of characteristics need to be taken into account in the selection process, not least the scion compatibility.

CHERRY

Cherry trees do not perform well on waterlogged soils and are also sensitive to chlorosis. As with any other fruit tree the right combination of rootstock, variety and training system is the key for success. The combination used should be adapted to the soil pH, texture as well as other factors such as chill hours.

With careful management it is possible to crop cherries in acidic or basic soils, with a planting density that can vary from 300 to 1000 trees per hectare, and also with fewer than 500 chill hours (< 7°C).

The first commercial harvest can be obtained from the third to the fifth year depending of the training system and rootstock. Yields can range from 10 to 25 t/ha depending on the variety (the earlier varieties give less production but usually command better prices).

Cherry trees are less water demanding than other stone fruits and can be cropped without irrigation in climates with 800 mm of rain per year, but the use of micro irrigation allows more effective water management and can help prevent cracking which is the main problem of the crop. Cracking can occur when there is rain close to harvest, when the cherries have begun coloration. For the same reason irrigation should be limited or avoided, once ripening has started.

From a fertilization point of view, a particularity of cherry trees is the short time from bloom to harvest. Because of this, the post-harvest fertilization is paramount, particularly the correct choice of the nutrients sources. Calcium is a key element in order to prevent cracking alongside the right nitrogen to potassium ratio. That is why the selection of the right source of nutrients is so important, as in many cases, calcium and potassium are supplied in the nitrate form. Boron, sodium and chloride are the key limiting factors in the irrigation water, as cherries are rather sensitive to the toxicity induced by these ions.

NECTARINE AND PEACH

The peach (*Prunus persica*) is a deciduous tree that grows from four to ten meters tall and belongs to the subfamily *Prunoideae* of the family *Rosaceae*. The nectarine (*P. persica* var. nectarine) is a cultivar of the same species as the peach. The major difference between the two is that the nectarine has smooth skin and the peach has needle-like, hairy or fuzzy skin. The process of pollination is somewhat simplified in peaches and nectarines in that only one ovule must be fertilized in order to set fruit.

The most limiting factor in peach profitability is late spring frost, and growers should plan on losing one in six or seven crops even in the best orchard locations. Peaches are very susceptible to waterlogged soils. Excellent internal soil drainage is essential to the long-term productivity and survival of the trees. The roots cannot grow without air in the soil profile. The ideal soil is a sandy loam topsoil that is at least 45 to 60 centimeters deep and is underlain with a well-drained red clay subsoil. The ideal soil pH for peach production is between 6 and 7.

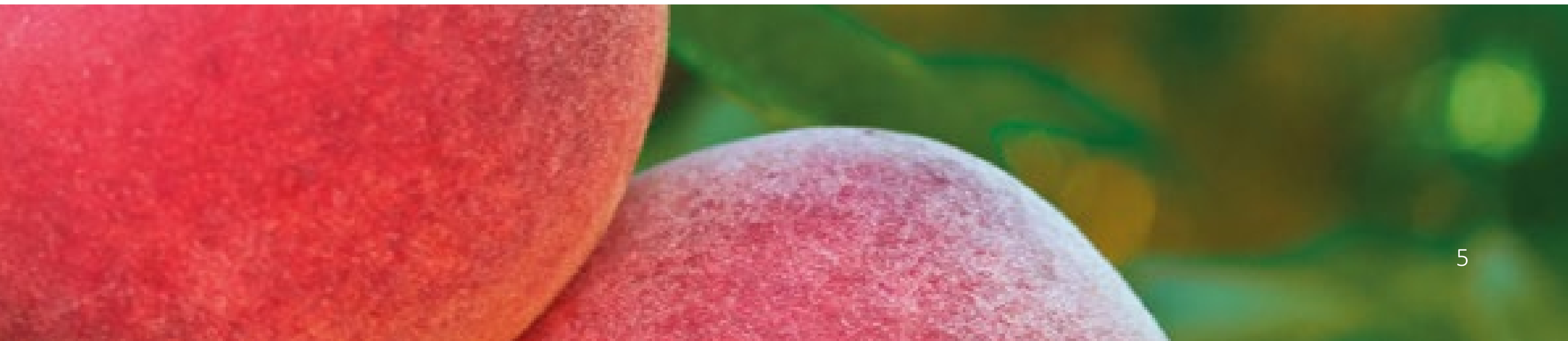
To keep the trees healthy and productive, nutrient levels should be maintained in the optimal range. The only accurate way to know what nutrients are needed is to have the soil and foliage tested. Young trees grow best with small, frequent fertilizations. Be extremely careful not to place fertilizers too close to the trunk. Fertilizers are salts that can potentially burn roots and kill young trees.

PLUM

Plums are a versatile stone fruit and are generally of reasonable hardiness. Commercial trees are mostly pruned to a height of five or six meters. The plum tree flowers in early spring and roughly half of the pollinated flowers develop into fruits. Flowering generally begins after 70-80 days of growth, but if the climate is too dry, fruit development may be hindered, with the immature fruits starting to drop from the trees. Plums that are harvested late risk infection from fungal diseases.

It is well known that the amount of fertilizer applied by farmers influences plum quality. Plant nutrition has been reported to affect fruit appearance, texture and taste. Post-harvest properties of plums, which affect the storage potential, are also dependent on the fertilization, because they affect the fruits' susceptibility to mechanical damage as well as physiological disorders.

The amount of phosphorus needed for plums is quite low, but in cases of phosphorus deficiency, developing shoots and fruits can be affected because they are especially sensitive to phosphorus levels. Plum trees under stress or suffering from poor nutrition, commonly caused by a lack of calcium, will have a reduced number of flowers reaching anthesis and also a reduced number of branches bearing flowers.



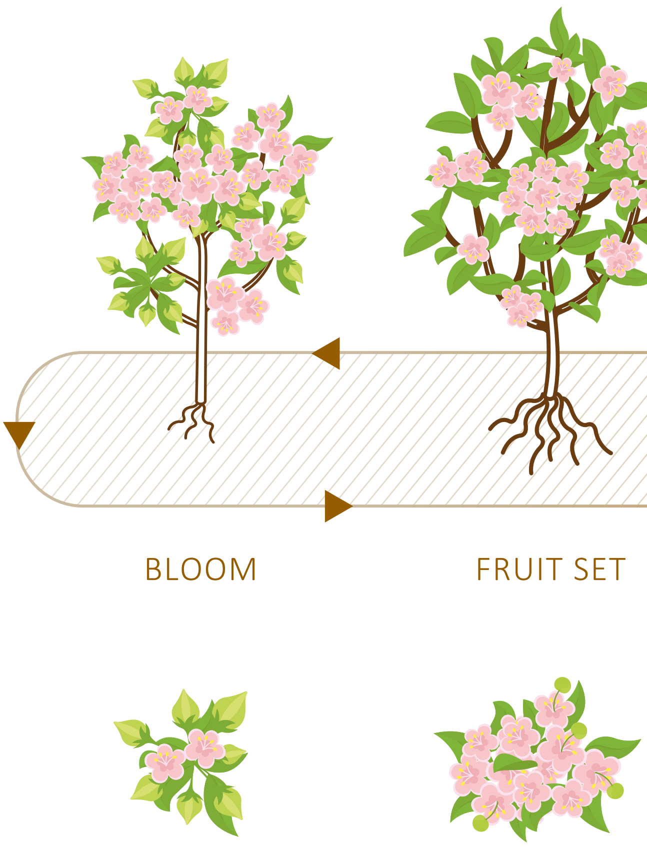
THE STONE FRUIT TREE GROWTH CYCLE

One of the key elements for the fertilization of stone fruits is to take into account the differences that exist between different types of stone fruit trees that are grown. The objectives will differ for each species although in all cases growers will almost certainly be aiming for good yields of fruits that have good size and color, high levels of sugar and that are sufficiently firm to resist storage and transport. In certain cases earlier ripening can increase market value and hence this may become the principal objective of production.

Fertilizer rates and application timings will have to be adjusted according to the requirements of each species. The requirements for nitrogen, phosphorus, potash, sulfur, calcium and magnesium are unique to each variety and these nutrients should be applied based on the results of soil analysis, nutrient removal and production practices. This is also required in order to adapt fertilizer inputs to nutrients that are already present in the soil. Regular tissue analysis is important to determine the content of various nutrients in the tissue and assist in defining the optimal fertilization program.

Environmental stresses combined with inappropriate nutrition can cause flower and seed abortion at critical developmental stages. Excessive fertilization can also cause plant stress which may favor the development of pests and diseases, particularly sap feeding insects. During flowering, the plant will adjust its fruit load (and thus yield) based on the number of flowers pollinated and the tree's nutritional status. After successful pollination and fertilization, the ovaries develop into the fruit and the ovules develop into the seeds, two additional processes that each have specific chemical and nutritional requirements. It is worth noting that the method of fertilizer application and the nutrient form will also have an impact on the nutrient use efficiency and hence the amount of fertilizer needed.

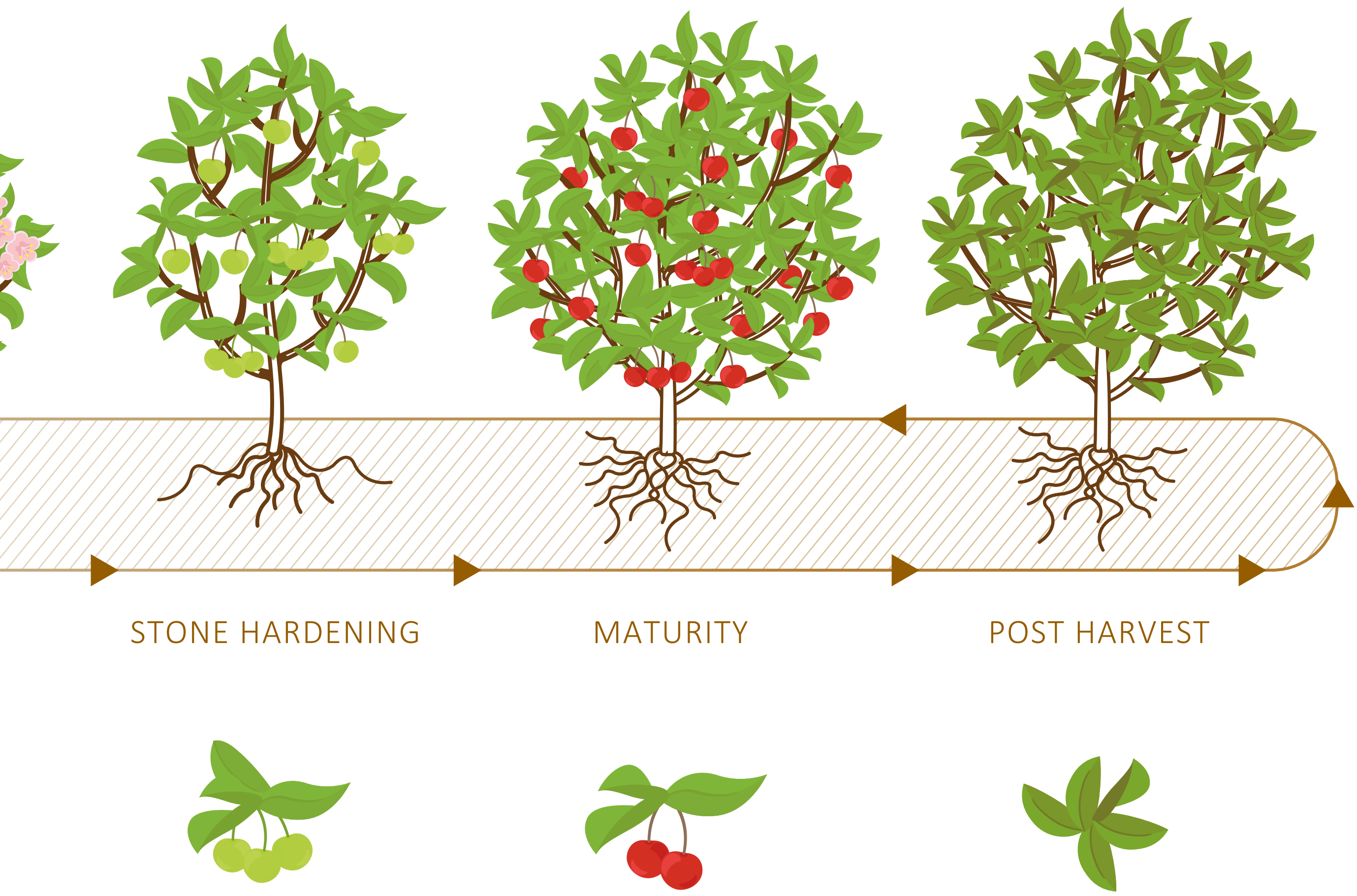
BLOOM	FRUIT SET
full bloom, 50% of open flowers	beginning of ovary
BBCH 65	BBCH 71



BLOOM

FRUIT SET

	STONE HARDENING	MATURITY	POST HARVEST
growth	fruits about 90% of final size	beginning of fruit coloring	
	BBCH 79	BBCH 81	BBCH 91



FERTILIZATION OBJECTIVES

Like all perennial trees, stone fruit trees start their vegetative cycle by using the reserves of carbon, nitrogen and calcium, which are mainly located in the roots and the branches. The growth dynamics of the main perennial and annual parts of stone fruit trees make the fertilization process complex, even without having to take into account any environmental constraints. The assimilation of the key nutrients from the soil and their metabolism and distribution depend on various processes.

After the months of winter rest, the stone fruit tree will simultaneously ensure the development and growth of its vegetative organs (branches, leaves and roots) and reproductive organs (inflorescences) until flowering. From bud break onwards, the leaves and branches will begin to grow. During their growth, the first leaves are initially heterotrophic (using carbon for growth and taking energy principally from reserves in the stems and roots). They then become autotrophic and use carbohydrates from photosynthesis. During all vegetative growth, magnesium can be a limiting nutrient and the need for magnesium can vary greatly from one stone fruit tree species to another. Most of the growth during this blooming period is driven by both nitrogen and carbon. Calcium nutrition will also influence the fruit quality. After flowering, potassium will help to obtain the full potential from each species of stone fruit tree, as it is an important nutrient when it comes to both yield and quality.

In many cases, the interaction between the nutrients in the tree and a balanced supply through fertilizer application is more important than the exact rates. For example, the development of fruit color is strongly affected by the balance between nitrogen and potassium. N and K levels for stone fruit trees depend on factors such as the cultivar, tree age, soil characteristics, ground cover and the irrigation method used.

NUTRITIONAL REQUIREMENTS OF STONE FRUIT TREES

1. Nitrogen (N)

Nitrogen is the nutrient that promotes the growth and vigor of the tree. It is one of the fundamental elements of plant nutrition, since it is included in the composition of chlorophyll.

The stone fruit tree continuously absorbs nitrogen from bud break to ripening, and its greatest need is at three time points. Firstly, when active growth restarts after bud break. Secondly, at flowering whereupon it is frequently found that the nitrogen is not readily available at that time. Finally, a third period where nitrogen is very important is when the fruit begins to grow rapidly.

Despite this, an excessive nitrogen supply can have a negative impact on the quality of stone fruits by reducing flesh firmness and sweetness, diminishing red color appearance and increasing susceptibility to disease and damage.

On the other hand, nitrogen deficiency can lead to small fruits with poor flavor. Stone fruit trees that are deficient in nitrogen tend to give a lower yield because of a shorter period of leaf maintenance, which leads to a shorter period for the accumulation of reserves during the post-harvest cycle.

A nitrogen application rate of 60 to 130 kg/ha/year is usually considered adequate for stone fruits.

2. Phosphorus (P)

Phosphorus is an essential nutrient both as a component of several key plant structures and as a catalyst in numerous key biochemical reactions in plants. Phosphorus is a vital component of adenosine triphosphate (ATP), the “energy unit” of plants. ATP forms during photosynthesis, has phosphorus in its structure, and is active from the beginning of seedling growth through to the formation of fruits and maturity.

Phosphorus is important for the general health and vigor of all plants including stone fruits. Some specific growth benefit that have been associated with phosphorus are: a stimulation of root development, increased branch strength, improved flower formation and fruit production, more uniform and earlier ripening, improved crop quality, increased resistance to disease, and more vigorous development throughout the growth cycle.

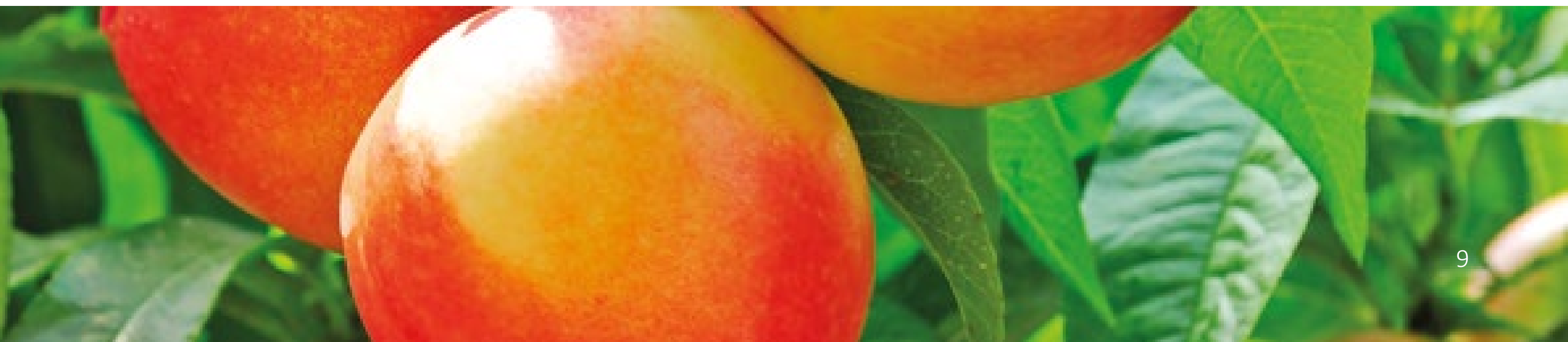
Phosphorus is an essential nutrient for all parts of the tree as it is required for membranes, energy molecules and nucleic acids. In cases of phosphorus deficiency, the fruit are more highly colored and ripen earlier but exhibit surface defects and poor flavor.

Leaf samples collected in mid-summer should have P values between 0.1 and 0.3%. If values drop below 0.12%, the trees will almost certainly benefit from the addition of a phosphorus fertilizer. Phosphorus deficiency in young leaves of stone fruit trees can be recognized by a dark green, purple, or bronze color with leaves looking stained. Petioles stand upright connecting with the leaf in a green half-moon shape with a purplish-red leaf margin. In severe cases, the edges of older leaves become dark brown and necrosis occurs, leading to early defoliation. Consequently, fruits remain small and do not reach full maturity. The fruits have a bland color, are hard and tend to be rather tasteless.

3. Potassium (K)

Potassium is an extremely important nutrient in regard to transpiration, chlorophyll uptake, and the transport and storage of carbohydrates in the fruits, helping to increase sugar content. It also helps to promote the storage of reserves in different parts of the plants. Potassium plays a role in orchard vigor and yield, and it contributes to the neutralization of formed organic acids. It also promotes respiration and activates growth. This is an important health factor for trees because it facilitates the proper distribution of reserves between different parts of the tree. It intervenes in the regulation of the opening and closing of stomata, thereby playing a role in improving drought resistance via better water use efficiency.

Potassium promotes the setting and advances the maturation of the fruits. It also helps protect against frost. In cases of potassium deficiency, stone fruit productivity, quality and storage potential are negatively affected. Poor fruit color (either a lack of color or dirty looking fruit) is observed in stone fruit trees suffering from potassium deficiency. Sugar content of fruits is also reduced. When potassium accumulation is excessive, total acidity decreases and fruit pH becomes unacceptably high, which may impact storage quality.



4. Sulfur (S)

The uptake of sulfur is not influenced by soil pH, although its availability may be reduced in highly acidic soils. This nutrient is thus usually taken up readily across a range of orchard soil conditions. In the tree, it is incorporated into certain amino acids (cysteine, methionine) and subsequently becomes part of certain enzymes, vitamins and oils. Once in these complex molecules, sulfur is not easily mobilized within the plant. Deficiency symptoms therefore will occur in the young tissue first.

Senescing leaves efficiently retrieve sulfur. As complex molecules are broken down, sulfur is converted into sulfate (SO_4^{2-}), which is readily transported out of the leaf and into the rest of the plant.

All proteins (and therefore enzymes) need sulfur to function, as disulfide bonds stabilize their structures. Sulphur also plays a key role in nitrogen metabolism. Sulfur contributes to the aroma of certain fruits through volatile sulfur compounds.

5. Calcium (Ca)

Calcium is another essential macronutrient that stone fruit trees thrive on. It improves both leaf and fruit quality. Calcium is involved in many plant processes including cell elongation, cell division, germination, pollen growth and senescence. One of its most important functions is the maintenance of membrane permeability and cell integrity. When it is deficient, cells become permeable and lose control over the import and export of nutrients, leading to tissue breakdown.

When calcium supply is inadequate or transport is disturbed, local calcium deficiencies will result. This can lead to membrane breakdown and/or cell wall failure; in fruit this can result in disorders such as blossom end rot. Whether this is actually the cause of such a disorder or whether calcium deficiency is a result of this condition has recently been debated.

Calcium (as the ion Ca^{2+}) is also an intracellular secondary messenger involved in many signal transduction pathways in stone fruit trees. Its irreplaceable function in this role and in cell wall polysaccharide interactions is undisputed. It is through these processes that calcium is central to stress responses, cell wall growth and remodeling, and to plant tissue development. Since Ca^{2+} is such a biologically active ion, its concentration and transport must be tightly controlled within plant tissue down to the level of cellular and extracellular compartments.

Calcium has an impact on the interior quality of stone fruits, and fertilization may have a positive or negative effect on the availability of calcium and its uptake from the soil. Fertilization in calcium deficient soils is a necessity and is also very important in acidic soils.

Calcium can be very helpful to reduce the impact of high heat on flowers. Heat stress during flowering can lead to pollination failure. Severe heat stress will also result in increased bud drop. After successful pollination and fertilization, the ovaries develop into the fruit and the ovules develop into the seeds, two additional processes that each have specific chemical and nutritional requirements that a plant nutrition product specially formulated for application during pollination can provide.

6. Magnesium (Mg)

Magnesium is a component of chlorophyll that intervenes in carbohydrate synthesis. In the fertilization of stone fruit trees, magnesium contributes to the absorption and migration of phosphorus, and it improves the capturing of iron in the fruit trees.

Its deficiency appears as chlorosis on the old leaves at the base of branches, which can fall prematurely and cause the appearance of secondary branches. Symptoms are more pronounced on leaves situated close to fruit clusters. Deficiency occurs by impairment, as well as by antagonism, with calcium and potassium. Magnesium deficiency can occur with light acidic soils that are prone to leaching or in soils that have received high rates of potassium fertilizers.

NUTRITIONAL REQUIREMENTS OF APRICOT						
	TOTAL PER MT OF YIELD*	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
	kg/ha	%				
N	3.7	5	10	15	35	35
P_2O_5	1.3	15	20	25	15	25
K_2O	5.6	5	10	20	40	25
SO_3	1	5	15	30	30	20
CaO	1.5	20	30	15	5	30
MgO	1	5	15	30	30	20

*Based on target yield 25 mT/ha

NUTRITIONAL REQUIREMENTS OF CHERRY						
	TOTAL PER MT OF YIELD*	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
	kg/ha	%				
N	2.5	10	25	30	10	25
P_2O_5	0.9	25	20	15	15	25
K_2O	3.86	5	15	25	30	25
SO_3	1	5	15	30	30	20
CaO	2.2	20	30	15	5	30
MgO	1.13	5	15	30	30	20

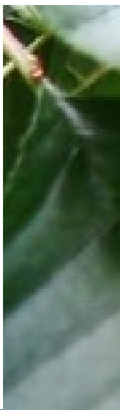
*Based on target yield 10 mT/ha

NUTRITIONAL REQUIREMENTS OF NECTARINE AND PEACH						
	TOTAL PER MT OF YIELD*	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
	kg/ha	%				
N	4	55	25	10	5	5
P_2O_5	0.25	35	35	30	0	0
K_2O	7	15	15	15	25	30
SO_3	2	0	20	40	40	0
CaO	1	20	20	20	20	20
MgO	0.66	25	25	10	20	20

*Based on target yield 24 mT/ha

NUTRITIONAL REQUIREMENTS OF PLUM						
	TOTAL PER MT OF YIELD*	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
	kg/ha	%				
N	4	35	20	15	15	15
P_2O_5	1.67	20	20	30	15	15
K_2O	7.33	10	10	30	40	10
SO_3	2.0	35	25	15	15	10
CaO	2.5	20	20	40	10	10
MgO	0.67	10	15	30	45	0

*Based on target yield 15 mT/ha




ABSORPTION OF NUTRIENTS

The absorption of nutrients by stone fruit trees depends considerably on the type of fruit that is grown. Generally speaking, for nitrogen the need arises after bud break.

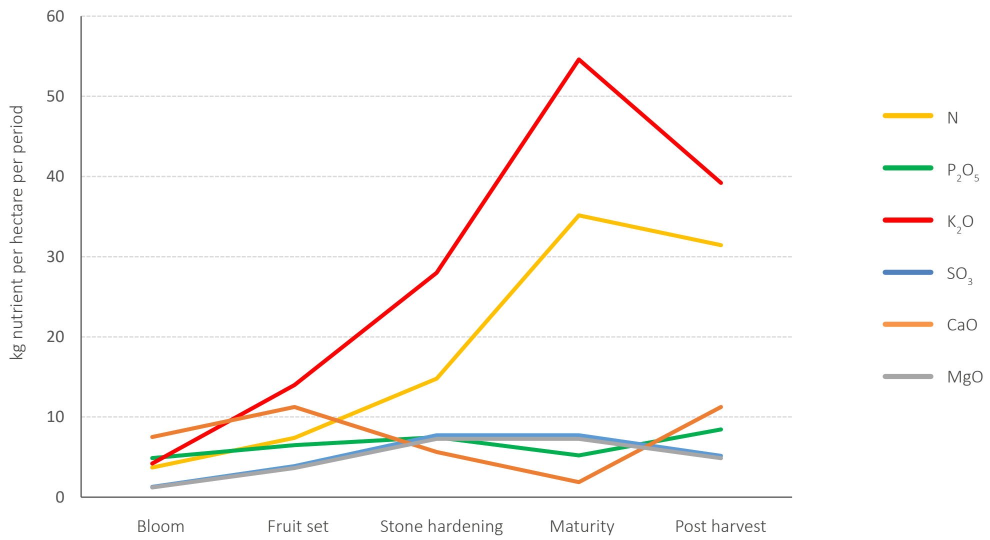
Calcium by nature allows for a better absorption of nitrogen and therefore calcium fertilizer should be provided to trees in anticipation of nitrogen. Calcium also plays an important role in the post-harvest fertilization to ensure fruit firmness in the next season's crop.

For phosphorus, the main inputs will take place between bud break and flowering. However, in some cases, assimilation may also take place during maturation.

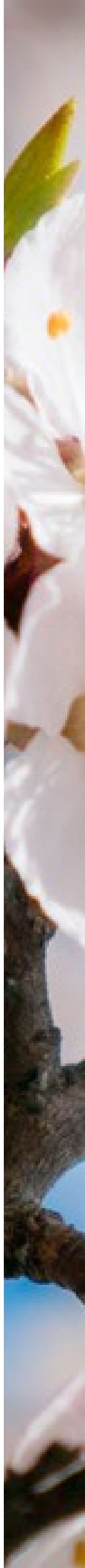
As regards potassium, generally speaking, the tree needs potash fertilization from flowering until maturation. Some stone fruits may need benefit from a potash boost after flowering in order to ensure a good supply of potassium before ripening.

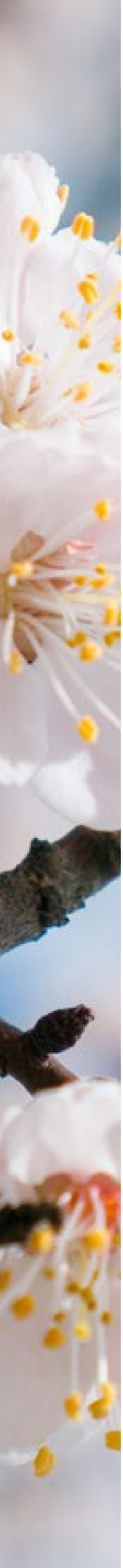
Sulfur is regularly absorbed throughout the growth cycle. Finally, in terms of magnesium, whilst the need is never very high, it remains a much appreciated nutrient during the entire cycle of the stone fruit tree. Its absorption is stronger from bud break until the beginning of maturation.

Apricot

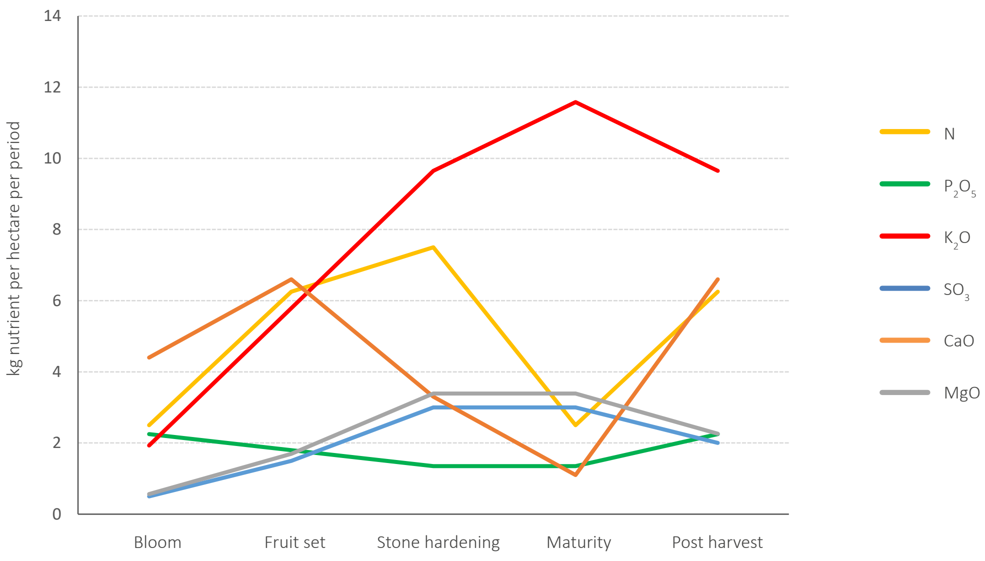


Nutrient uptake curve of apricots for crop yield of 25 T/ha



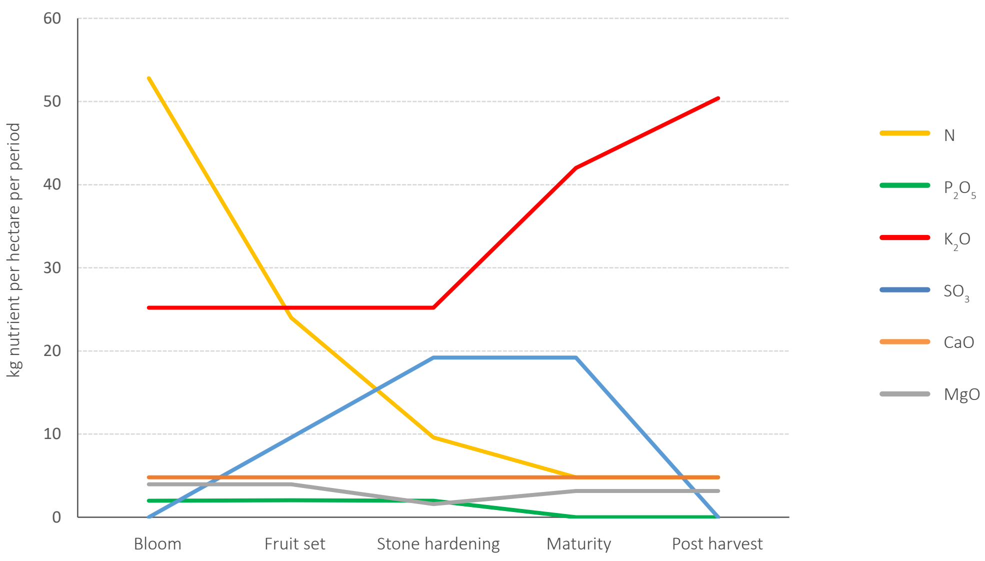


Cherry



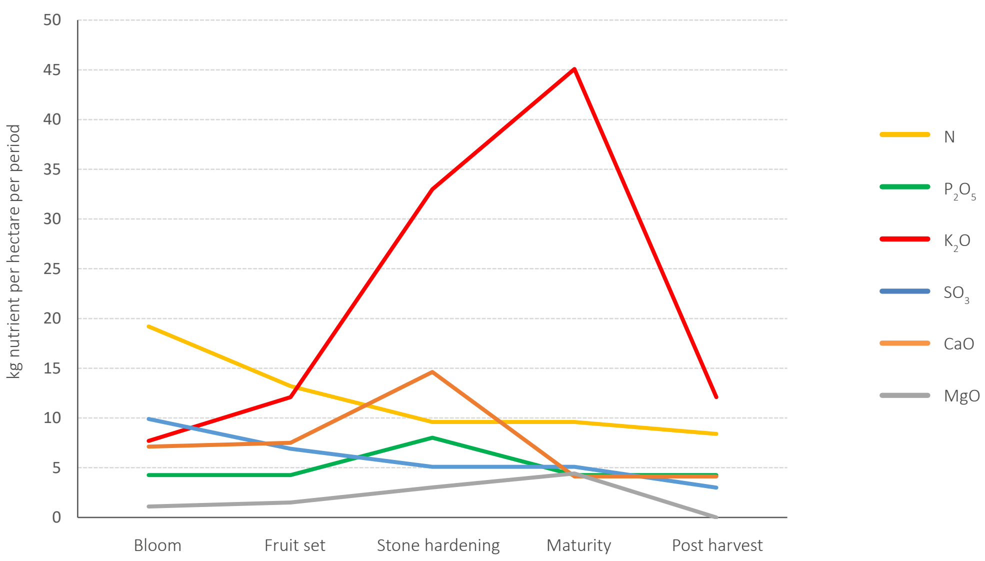
Nutrient uptake curve of cherry for crop yield of 10 T/ha

Nectarine and peach



Nutrient uptake curve of nectarine and peach for crop yield of 24 T/ha

Plum



Nutrition uptake curve of plum (*cv: Ente*) for crop yield of 15 T/ha

PRODUCTS

TESSENDERLO KERLEY FERTILIZERS

PRODUCTS	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
Thio-Sul	Soil application liquids	Soil application liquids	Soil application liquids	Soil application liquids	Soil application liquids
KTS		Foliar application	Fertigation / Foliar application	Fertigation / Foliar application	Fertigation / Soil application liquids
CaTs	Foliar application	Foliar application	Fertigation / Foliar application	Fertigation / Foliar application	Fertigation / Soil application liquids
K-Leaf		Foliar application	Foliar application	Foliar application	
SoluPotasse		Fertigation	Fertigation	Fertigation	
GranuPotasse	Soil application granules				Soil application granules

Legend:

Foliar application   Soil application granules   Soil application liquids   Fertigation

NUTRIENT CONVERSION FACTORS*		
TO CONVERT	TO	DIVIDE BY
CaO	Ca	1.40
MgO	Mg	1.66
K_2O	K	1.20
P_2O_5	P	2.29
SO_3	S	2.50
SO_4	S	3.00

* To convert elemental units to oxide units multiply by the same factors

THIO-SUL

Characteristics and advantages

- Sulfur and nitrogen source without chloride.
- The addition of Thio-Sul transforms UAN into a stabilized nitrogen fertilizer.
- Sulfur in the unique thiosulfate form is a highly effective sulfur source, which is partly available immediately, and which is partly available over a period of several weeks.
- The leachability is significantly lower than with sulfur in the sulfate form.
- Promotes thiobacillus stimulation and especially the microbiological activity in the soil.
- Releases nutrients that are present in the soil.

Specifications

Ammonium thiosulfate	
- N (w/w) as ammoniacal nitrogen	12%
- S (w/w)	26%

Typical properties

- Appearance/color	Clear, colorless to light yellow
- pH range	6.5 - 8.5
- Density range (at 25°C)	1.32 kg/l - 1.35 kg/l
- Density (at 25°C)	1.33 kg/l
- Salt Out Temperature (SOT)	+ 7°C
- SO_3 (w/w)	64.9%
- N (w/v) as ammoniacal nitrogen	16%
- S (w/v)	34.6%
- SO_3 (w/v)	86.3%
- N (g/l) as ammoniacal nitrogen	160
- S (g/l)	346
- SO_3 (g/l)	863
- Chemical formula	$(NH_4)_2S_2O_3$

APPLICATION	RATE PER APPLICATION	GROWTH STAGE	COMMENT
Soil application – soil injection and surface banding	45 to 90 l/ha	Early in the growing season for sulfur nutrition	Take care to avoid damaging roots during injection application
Soil application – broadcast (mature trees)	95 to 110 l/ha	Early in the growing season for sulfur nutrition	Spray alone or mixed with water and/or other liquid fertilizers. Prevent spray and drift from contacting foliage and tree bark.
Soil application – broadcast (young trees)	45 to 75 l/ha	Early in the growing season for sulfur nutrition	Spray alone or mixed with water and/or other liquid fertilizers. Prevent spray and drift from contacting foliage and tree bark.
Flood and in furrow	45 to 90 l/ha	Starting at full leaf	Apply with the irrigation water

KTS

Characteristics and advantages

- The concentrated liquid form is ideal for applications in low water volumes and for large areas.
- Active thiosulfate technology enhances the uptake of phosphorus and micronutrients present in the soil or from fertilization.
- The neutral pH level is ideally adapted to tank mixtures with acid or base sensitive materials.
- KTS contains the two key crop nutrients potassium and sulfur, and it is chloride and nitrate free.
- Available in bulk and in 1,000 l containers.
- Can also be applied to the soil as a starter fertilizer (with P-Sure®) and in overhead pivots and sprinklers.
- The thiosulfate form of potassium is taken up rapidly by the leaves.

Specifications

Potassium thiosulfate

- K_2O (w/w)	25%
- S (w/w)	17%
- pH range	6.8 - 8.5
- Density range (at 25°C)	1.45 - 1.49

Typical properties

- Appearance/color	Clear and colorless
- Density (at 25°C)	1.47 kg/l
- Salt Out Temperature (SOT)	- 10°C
- SO_3 (w/w)	42.4%
- K_2O (w/v)	36.8%
- S (w/v)	25%
- SO_3 (w/v)	62.4%
- K_2O (g/l)	368
- S (g/l)	250
- SO_3 (g/l)	624
- Chemical formula	$K_2S_2O_3$

APPLICATION	RATE PER APPLICATION	GROWTH STAGE	COMMENT
Flood and in furrow	45 to 110 l/ha	Starting at full leaf	Apply once every 2 to 3 weeks
Fertigation (sprinkler/pivot) – under canopy	45 to 75 l/ha	Starting at full leaf	Apply every 10 to 14 days based on crop requirements
Fertigation (sprinkler/pivot) – overhead	30 to 45 l/ha	Starting at full leaf	Apply every 10 to 14 days based on crop requirements
Fertigation (drip) – young trees	30 to 45 l/ha	Starting at full leaf	Apply once every 3 to 4 weeks
Fertigation (drip) – mature trees	45 to 95 l/ha	Starting at full leaf	Apply once every 3 to 4 weeks
Fertigation (micro sprinkler) – young trees	25 to 50 l/ha	Starting at full leaf	Apply once every 3 to 4 weeks
Fertigation (micro sprinkler) – mature trees	55 to 110 l/ha	Starting at full leaf	Apply once every 3 to 4 weeks
Foliar	5 to 15 l/ha	Begin application at first full leaf and apply as needed during the growing season	Apply in a minimum of 1000 liters of water spray solution. For concentrated sprays of less than 1000 liters per hectare, reduce the rate of KTS so as not to exceed the maximum spray solution concentration of 1.5%. See also caution on page 26

CATS

Characteristics and advantages

- CaTs is a neutral to basic, chloride and nitrate free, clear solution.
- CaTs may be applied by drip, sprinkler, or flood irrigation.
- It may be blended with other fertilizers or applied as a foliar treatment on selected crops.
- When used as a foliar fertilizer, CaTs should first be diluted with water before application.
- Blends of CaTs should not be acidified below a pH of 6.0.
- CaTs may be used as a fertilizer for the correction of calcium deficiency.
- CaTs is an effective water soluble source of calcium and thiosulfate sulfur which assists in the correction of these nutrient deficiencies in crops.
- CaTs may be used to improve water infiltration and assists in terms of leaching of harmful soil salts.
- CaTs is compatible with most fertilizer solutions.
- CaTs is not compatible with phosphate, sulfate and ammonium thiosulfate fertilizers.

Specifications

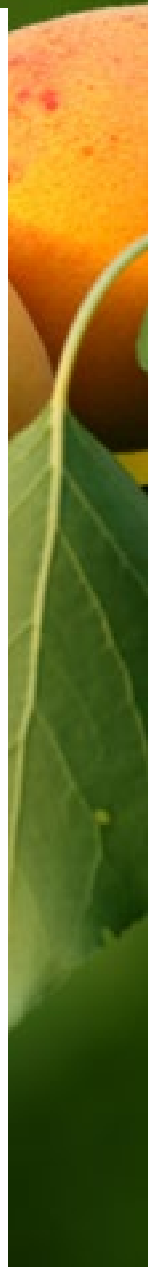
Calcium thiosulfate	
- Ca (w/w)	6%
- S (w/w)	10%
- pH range	6.5 - 8.8
- Density range (at 25°C)	1.22 - 1.26

Typical properties

- Appearance/color	Clear and colorless
- Density (at 25°C)	1.25 kg/l
- Salt Out Temperature (SOT)	0°C
- CaO (w/w)	8.4%
- SO_3 (w/w)	25%
- Ca (w/v)	7.5%
- S (w/v)	12.5%
- CaO (w/v)	10.5%
- SO_3 (w/v)	31.2%
- Ca (g/l)	75
- S (g/l)	125
- CaO (g/l)	105
- SO_3 (g/l)	312
- Chemical formula	CaS_2O_3

APPLICATION	RATE PER APPLICATION	GROWTH STAGE	COMMENT
Soil	100 to 200 l/ha	Apply as needed during the growing season	
Fertigation (sprinkler/pivot) – young trees	30 to 75 l/ha	Starting at full leaf	Repeat as required
Fertigation (sprinkler/pivot) – mature trees	45 to 95 l/ha	Starting at full leaf	Repeat as required
Fertigation (drip) – young trees	30 to 80 l/ha	Starting at full leaf Repeat 4 or 5 times during the growing season	Allow 10 to 14 days between applications
Fertigation (drip) – mature trees	50 to 100 l/ha	Starting at full leaf Repeat 4 or 5 times during the growing season	Allow 7 to 8 days between applications
Foliar	5 to 10 l/ha	Repeat applications as required (up to 4 or 5 applications)	Allow 10 days between each application See also caution on page 26

K-LEAF



Characteristics and advantages

- The highly soluble potash booster is suitable for foliar applications using regular spray volumes.
- K-Leaf is well suited for foliar application at higher potash rates per hectare.
- K-Leaf dissolves three times as fast as regular water soluble SOP, leaving no residues.
- The acidification effect may in some cases have a beneficial impact on absorption of tank mix partners.
- K-Leaf is a cost-effective source of potassium and sulfur and is chloride and nitrate free.
- Available in 20 kg bags.
- K-Leaf can be applied at higher rates than certain other foliar potassium fertilizers.
- K-Leaf has now been verified as compliant for use in organic agriculture according to EC Regulation no. 834/2007.

Specifications

Potassium sulfate	
- K_2O (w/w)	Min. 51.5%
- Cl (w/w)	Max. 0.5%
- S (w/w)	18.7%

Typical properties

- Appearance/color	Fine white powder
- Bulk density (struck/loose)	1.53 kg/l / 1.25 kg/l
- Angle of repose	35°
- pH (1% solution)	2.9
- Residues (5% solution)*	0.03%
- Solubility at 25°C	120 g/l pure water
- Dissolved after 1 min with stirring	90%
- K_2O (w/w)	52%
- Cl (w/w)	0.2%
- SO_3 (w/w)	47%
- H_2O (w/w)	0.07%
- Chemical formula	K_2SO_4

* After stirring for 10 minutes at 25°C

APPLICATION	RATE PER APPLICATION	GROWTH STAGE	COMMENT
Foliar	7 to 14 kg/ha	After flowering	2 to 3 applications Do not exceed a concentration of 3% of K-Leaf (w/w) in the spray solution

SOLUPOTASSE

Characteristics and advantages

- SoluPotasse is a cost-effective source of potassium and sulfur and is chloride and nitrate free.
- SoluPotasse provides a high concentration of these important crop nutrients.
- SoluPotasse dissolves rapidly and completely, leaving no residues.
- SoluPotasse has an extremely low salt index and is ideal for use in chloride sensitive crop or regions at risk from salinity.
- The acidification effect ensure optimal uptake of all nutrients and helps prevent clogging of the drippers.
- SoluPotasse is of a consistently high quality and is the market leading water soluble SOP for fertigation.
- Available in 25 kg bags and big bags (1000 kg or 1200 kg).

Specifications

Potassium sulfate	
- K_2O (w/w)	Min. 51%
- Cl (w/w)	Max. 1%
- S (w/w)	18.7%

Typical properties

- Appearance/color	Fine white powder
- Bulk density (struck/loose)	1.46 kg/l / 1.21 kg/l
- Angle of repose	40°
- pH (1% solution)	2.9
- Residues	0.03%
- Solubility at 25°C	120 g/l pure water
- Dissolved after 3 mins with stirring	90%
- K_2O (w/w)	51.5%
- Cl (w/w)	0.6%
- SO_3 (w/w)	47%
- H_2O (w/w)	0.02%
- Chemical formula	K_2SO_4

APPLICATION	RATE PER APPLICATION	GROWTH STAGE	COMMENT
Fertigation	10 to 20 kg/ha per week	Beginning of flowering	Based on weekly applications
	20 to 30 kg/ha per week	End of flowering Beginning of fruit set	
	30 to 40 kg/ha per week	Beginning of fruit flush	
	20 to 30 kg/ha per week	End of fruit flush	

GRANUPOTASSE

Characteristics and advantages

- GranuPotasse is a cost-effective source of potassium and sulfur, and it is chloride and nitrate free.
- GranuPotasse provides a high concentration of these important crop nutrients.
- GranuPotasse is virtually dust-free.
- GranuPotasse has a consistent granulometry that ensures uniform application, with a spreading range of up to 28 meters.
- GranuPotasse is suitable for both pre-emergence and post-emergence application during early stages of crop growth.
- GranuPotasse has excellent stability, which makes it ideal for producing a wide variety of NPK blends.
- Available in 25 kg bags or big bags (600 kg, 1,000 kg or 1,200 kg).

Specifications

Potassium sulfate	
- K_2O (w/w)	Min. 50%
- Cl (w/w)	Max. 2.5%
- S (w/w)	18%

Typical properties

- Appearance/color	Light grey to beige granules
- Bulk density (struck/loose)	1.40 kg/l / 1.27 kg/l
- Angle of repose	33°
- Sieve analysis	97% between 1.6 mm and 5 mm
- K_2O (w/w)	50.2%
- Cl (w/w)	2.3%
- SO_3 (w/w)	45%
- H_2O (w/w)	0.2%
- Chemical formula	K_2SO_4

APPLICATION	RATE PER APPLICATION	GROWTH STAGE	COMMENT
Soil application	160 to 400 kg/ha	Prior to planting or during the winter rest period	Apply either soil incorporated prior to planting or apply annually as a basal dressing

FERTILIZATION RECOMMENDATIONS

FERTIGATION RECOMMENDATIONS

The fertigation recommendations presented are for illustrative purposes only. Many different products are available for use in fertigation and the final product choice will depend on many different factors. Always consult a qualified agronomist beforehand.

FERTILIZATION FOR APRICOT BASED ON NUTRIENT REQUIREMENTS						
	TOTAL	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
Nitrogen (kg N/ha)	60-125	0-5	5-10	10-20	25-50	20-40
Phosphorus (kg P_2O_5/ha)	25-50	5-10	5-10	5-10	5-10	5-10
Potassium (kg K_2O/ha)	95-190	5-10	10-20	20-40	35-70	25-50
Sulfur (kg SO_3/ha)	20-35	0-5	5	5-10	5-10	5
Calcium (kg CaO/ha)	25-50*	5-10	10-15	0-5	0-5	10-15
Magnesium (kg MgO/ha)	15-35	0-5	0-5	5-10	5-10	5

Based on the quantity of nutrients mobilized – *except calcium (quantity exported)

TESSENDERLO KERLEY FERTIGATION RECOMMENDATIONS FOR APRICOT					
	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
LIQUIDS					
KTS (l/ha)	10-15	25-50	50-100	100-200	70-140
CaTs (l/ha)	50-100	70-140	35-70	15-25	70-140
WATER SOLUBLES					
SoluPotasse (kg/ha)	5-10	20-40	40-75	70-140	50-100

FERTILIZATION FOR CHERRY BASED ON NUTRIENT REQUIREMENTS						
	TOTAL	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
Nitrogen (kg N/ha)	15-35	0-5	5-10	5-10	0-5	5-10
Phosphorus (kg P_2O_5/ha)	6-12	2-3	1-2	1-2	1-2	1-3
Potassium (kg K_2O/ha)	25-55	0-5	5-10	5-15	10-15	5-10
Sulfur (kg SO_3/ha)	5-13	0-1	1-2	2-4	2-4	1-3
Calcium (kg CaO/ha)	15-30*	4-6	4-9	2-4	1-2	4-9
Magnesium (kg MgO/ha)	8-15	0-2	1-2	2-5	2-5	2-3

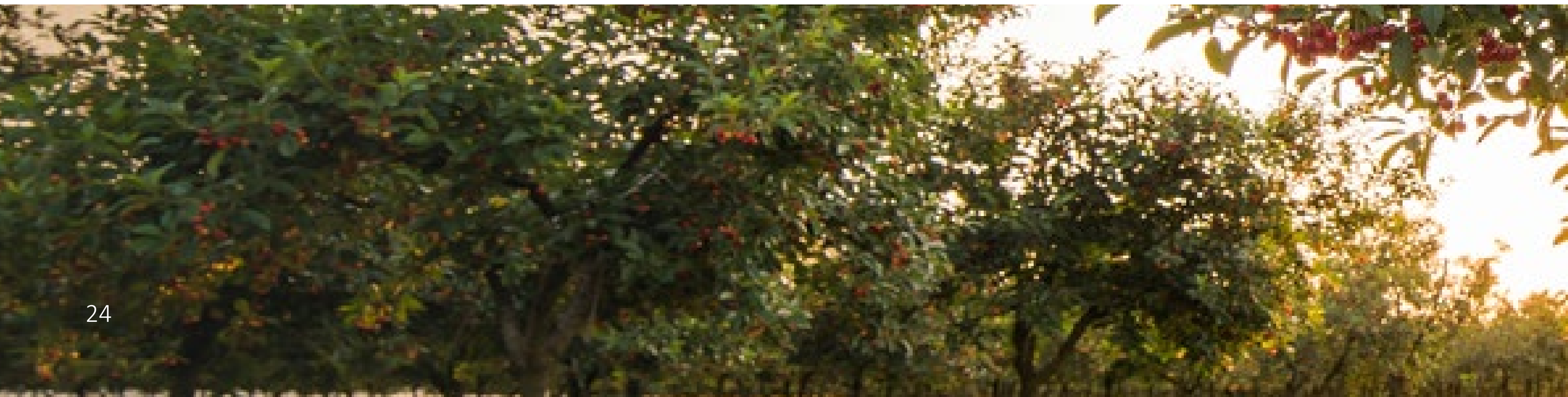
Based on the quantity of nutrients mobilized – *except calcium (quantity exported)

TESSENDERLO KERLEY FERTIGATION RECOMMENDATIONS FOR CHERRY					
	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
LIQUIDS					
KTS (l/ha)	5-10	10-20	15-35	20-40	15-35
CaTs (l/ha)	30-55	40-85	20-40	5-15	40-85
WATER SOLUBLES					
SoluPotasse (kg/ha)	0-5	10-15	15-25	15-30	15-25

FERTILIZATION FOR NECTARINE AND PEACH BASED ON NUTRIENT REQUIREMENTS						
	TOTAL	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
Nitrogen (kg N/ha)	65-130	35-65	15-30	5-15	5-10	5-10
Phosphorus (kg P_2O_5/ha)	4-10	1-3	2-4	1-3	0	0
Potassium (kg K_2O/ha)	115-225	20-35	20-35	20-35	25-55	30-65
Sulfur (kg SO_3/ha)	35-65	0-5	5-10	15-25	15-25	0
Calcium (kg CaO/ha)	15-30*	3-6	3-6	3-6	3-6	3-6
Magnesium (kg MgO/ha)	10-20	3-5	3-5	0-2	2-4	2-4

Based on the quantity of nutrients mobilized – *except calcium (quantity exported)

TESSENDERLO KERLEY FERTIGATION RECOMMENDATIONS FOR NECTARINE AND PEACH					
	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
LIQUIDS					
KTS (l/ha)	45-90	45-90	45-90	75-150	90-180
CaTs (l/ha)	30-60	30-60	30-60	30-60	30-60
WATER SOLUBLES					
SoluPotasse (kg/ha)	35-65	35-65	35-65	55-110	65-130

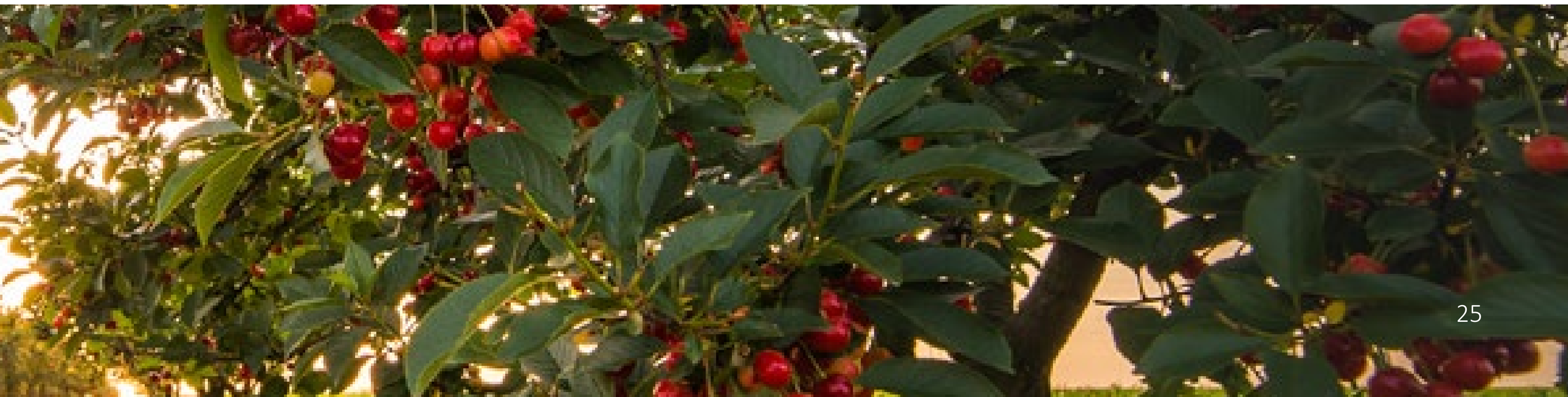


FERTILIZATION FOR PLUM BASED ON NUTRIENT REQUIREMENTS						
	TOTAL	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
Nitrogen (kg N/ha)	50-90	15-30	10-20	10-15	10-15	5-10
Phosphorus (kg P_2O_5/ha)	20-35	5	5-10	5-10	5	0-5
Potassium (kg K_2O/ha)	100-150	5-10	10-15	30-45	45-65	10-15
Sulfur (kg SO_3/ha)	20-35	5-10	5-10	5	5	0-5
Calcium (kg CaO/ha)	35-45*	5-10	5-10	15	5	5
Magnesium (kg MgO/ha)	5-15	0-5	5	5-10	10-15	0

Based on the quantity of nutrients mobilized – *except calcium (quantity exported)

TESSENDERLO KERLEY FERTIGATION RECOMMENDATIONS FOR PLUM					
	BLOOM	FRUIT SET	STONE HARDENING	MATURITY	POST HARVEST
LIQUIDS					
KTS (l/ha)	20-30	30-45	80-120	110-170	30-45
CaTs (l/ha)	60-70	65-75	130-150	35-40	35-40
WATER SOLUBLES					
SoluPotasse (kg/ha)	15-20	25-30	60-90	80-120	20-30

GranuPotasse, as a solid fertilizer, can be applied on soil as a potassium and sulfur source. Foliar sprays of K-Leaf potash booster can also complement fertigation.



GUIDELINES

General

- Do not apply products to crops which are sensitive to the effects of sulfur.
- Micronutrient blends should be jar tested first before mixing with thiosulfates. In most situations, micronutrient chelates of neutral pH are preferred for blending with thiosulfates. Strongly acidic and/or weak chelates do not blend well with thiosulfates. Blends of thiosulfates should not be acidified below a pH of 6.0.
- Use the correct type of spray nozzles that are recommended for foliar applications.
- Use of tissue and soil analysis to determine crop and soil nutrient status is recommended.
- Contact a representative of Tessenderlo Kerley International if you require any additional information on the properties, benefits and use of the products in this guide.
- The purpose of this brochure is to provide information about fertilizer products and to make suggestions regarding their use in stone fruit trees. The exact quantities of nutrients required by the crop will depend on local growing conditions including, but not limited to, soil type and nutrient content, climate conditions; crop variety, target yield, etc.
- Tessenderlo Kerley International recommends that you seek advice on your specific fertilization program from a qualified agronomist.

Liquids

- Do not apply products to soils that have a very low pH level.
- Do not apply products as a foliar spray when temperatures are, or will be, above 30°C or when humidity drops below 30%. Ensure you apply products (preferably) early in the morning or in the evening.
- **ALWAYS CONSULT WITH OUR EXPERTS** if intending to apply foliar thiosulfate with a crop oil spray, or shortly before and/or after an oil spray.

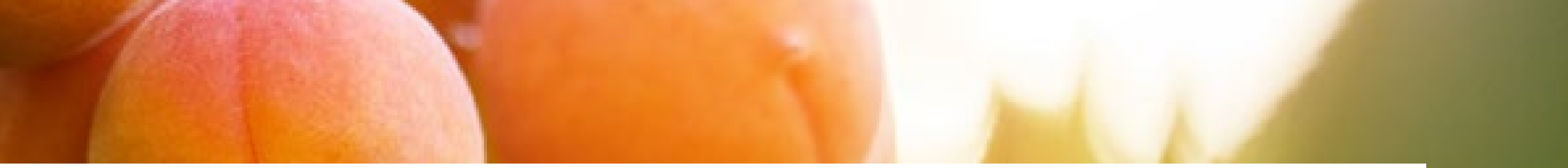
CAUTION: Foliar applications of thiosulfates may in some cases cause flower thinning in stone fruit trees

Blending of liquids

- The original salt out temperature (SOT) of each liquid in a blend can change when mixed with other liquid fertilizers or other liquid micronutrients and/or pesticides.
- When mixing with other products, and in the absence of specific recommendations and data, you are strongly advised to conduct a small-scale trial (jar test) in order to check the physical compatibility of the mixture before operating on a larger scale and applying.
- For blending the sequence should be to add:

  1. 50% of the total water volume
  2. Liquid fertilizers for other N and/or P sources
  3. Thiosulfate fertilizers
  4. Compatible micronutrients
  5. Pesticides
  6. Complete the filling of the spray tank with the remaining 50% of the water

- KTS is compatible with urea and APP in any ratio. When blending KTS with UAN, always have as much water, by weight, in the blend as the UAN solution. Potassium (from KTS) may react with nitrates to form potassium nitrate crystals. If this should happen the addition of water and/or gentle heating should bring it back to clear solution.
- CaTs is not compatible with phosphate, sulfate and ammonium thiosulfate fertilizers.
- The recommendations in this guide are for KTS, CaTs and Thio-Sul applied alone (not in blends). The addition of other products to the mix is the responsibility of the operator and not of Tessenderlo Kerley International. In case of doubt always consult a qualified agronomist.



Water solubles

- Continuous agitation or stirring will speed up dissolution.
- The time required to dissolve the product, however, will also depend on the quality and temperature of the water. Poor quality water may affect solubility.
- To get the best results from the products:

    1. Fill the tank with water to at least 2/3^{rds} of its capacity.
    2. Add the product taking care not to exceed the maximum recommended concentration.
    3. Maintain stirring or agitation throughout the entire operation.
    4. Fill the remainder of the tank with water.
    5. Check that the product has dissolved completely before using the solution.
    6. The use of filters is recommended, as generally advised for most solid fertilizers when used in solution.

- Do not apply products as a foliar spray when temperature exceeds 30°C - apply products preferably early in the morning or in the evening.
- Do not mix sulfates with materials containing calcium.
- When mixing with other products it is recommended to conduct a small-scale trial (jar test) to check the compatibility of the mixture before operating on a larger scale.
- Store products in dry conditions, avoiding extreme heat or cold.

Always respect and comply with local legislation and regulation regarding the use of fertilizer products.

SUSTAINABLE CROP NUTRITION FOR AGRICULTURE

For over 100 years Tessenderlo Kerley International has demonstrated its commitment to nurturing crop life through innovation, research and the development of novel fertilizers for a more sustainable agriculture. Our diverse product portfolio addresses the challenges of modern agriculture by delivering essential nutrients in forms that protect soil health and optimize nutrient use efficiency.

We provide an extensive range of both liquid and solid/soluble fertilizers

KTS · CaTs · SoluPotasse · Solucros

HIGH-PERFORMANCE LIQUIDS

HIGH QUALITY SOLID/SOLUBLES

MagThio · Thio-Sul · K-Leaf · GranuPotasse

Our experts are familiar with your region and crops.
Their support includes:

- Agronomic advice
- Providing technical information
- Carrying out field studies that are specific to your issues
- Providing application and storage tips

For more contact information, please get in touch with:

Tessenderlo Kerley International, part of Tessenderlo Group
Troonstraat 130 - 1050 Brussels, Belgium
Tel. +32 2 639 18 11
tessenderlokerley@tessenderlo.com
www.tessenderlokerley.com

TESSENDERLO Kerley