Nutrient Management Guide (RB209)

Updated February 2020

AHDB

FACTS

Section 7 Fruit, vines and hops

Acknowledgements

Funding for the production of this section of the Nutrient Management Guide (RB209) is provided by AHDB.

Revision of the Fertiliser Manual (RB209) to create the Nutrient Management Guide (RB209) has been overseen by the UK Partnership for Crop Nutrient Management, which is led by AHDB.

AHDB wishes to thank all those who freely give their time to serve on the Steering Group, as well as the Arable, Horticulture and Livestock Technical Working Groups. AHDB also wishes to thank the numerous farmers and growers across the country who host trials.

Horticulture Technical Working Group:
Agrii, Agrovista, AHDB, Bord na Mona, Bulrush, DARD, Defra, Engage Agro, Freshgro, Hortifeeds, Hutchinsons, ICL group, J&A Growers, Lucozade Ribena Suntory, New Forest Fruits, OMEX Agriculture Ltd, PGRO, Omya, SAC Consulting, Sinclair Pro, STRI, Teagasc and Welsh Government.

Steering Group:
AHDB, Agricultural Industries Confederation, Association of Independent Crop Consultants, BBRO, Catchment Sensitive Farming, DAERA, Defra, FACTS, PGRO, Professional Nutrient Management Group, Scottish Government and Welsh Government.

Funding for trials was provided by:

AHDB

Research providers:
The revision of this section of the Nutrient Management Guide (RB209) was carried out by a consortium led by ADAS.

ADAS NIAB EMR

Greenhouse Gas Action Plan:
The industry-wide Greenhouse Gas Action Plan (GHGAP) for agriculture focuses on improving resource use efficiency in order to enhance business performance while reducing GHG emissions from farming.

greenhouse gas action plan

Using the Nutrient Management Guide (RB209)

The Nutrient Management Guide (RB209) helps you make the most of organic materials and balance the benefits of fertiliser use against the costs – both economic and environmental. The guide outlines the value of nutrients and soil, and explains why good nutrient management is about more than just fertilisers. It can save you money as well as help protect the environment.

AHDB first published the Nutrient Management Guide (RB209) in May 2017. Since its publication, recommendations have been revised, with the latest independent research funded by AHDB and its partners. A list of updates is available at **ahdb.org.uk/rb209**

To improve the accessibility and relevance of the recommendations and information, the Nutrient Management Guide (RB209) is published as seven sections that are updated individually.

Keep informed

The Nutrient Management Guide (RB209) will be updated regularly. Please email your contact details to **comms@ahdb.org.uk** so that we can send you notifications of when they are published.

RB209: Nutrient Management

Download the app for Apple or Android devices to access the current version of the guide. With quick and easy access to videos, information and recommendations, it is practical for use in the field.

This section provides guidance for fruit, vines and hops. For each crop, recommendations for nitrogen (N), phosphate (P_2O_5), potash (K_2O), magnesium (MgO) and sulphur (as SO_3) are given in kilograms per hectare (kg/ha).

Recommendations are given for the rate and timing of fertiliser application. The recommendations are based on the nutrient requirements of the crop being grown, making allowance for the nutrients supplied by the soil.

Always consider your local conditions and consult a FACTS Qualified Adviser if necessary.

Contents

Checklist for decision-making

Individual decisions for fertiliser use must be made separately for every field. Where more than one crop is grown in a field, these areas must be considered individually.

1. Confirm the crop to be grown and the intended market. Identify any crop quality requirements for this market.
2. Identify the dominant soil type in the cropped area (**Section 1: Principles of nutrient management and fertiliser use**).
3. Assess soil structure and take action to remove compaction and improve drainage if necessary. Poor structure and drainage can restrict crop growth, resulting in poor nutrient use efficiency.
4. Carry out soil analysis for pH, P, K and Mg before planting and every 3–5 years (**Section 1: Principles of nutrient management and fertiliser use**). Target values to maintain when growing fruit, hops or vines are:
   - Soil pH 6.0–6.5 (6.5–6.8 before planting)
   - Soil P Index 2
   - Soil K Index 2 (cider apples respond to Soil K Index 3)
   - Soil Mg Index 2 (cider apples respond to Soil Mg Index 3)
5. Calculate the total and crop-available nutrients from organic materials that have been applied since harvest of the previous crop, or which will be applied to the crop being grown (**Section 2: Organic materials**). Deduct these nutrients from the recommended rates given in the tables.
6. Use regular leaf and fruit analysis to help make fertiliser decisions. Soil levels are not always reflected in the nutrient concentrations in the leaf and fruit.
7. Decide on the strategy for phosphate, potash and magnesium use. This will be either building up, maintaining or running down the Soil Index levels (**Section 1: Principles of nutrient management and fertiliser use**). Allow for any surplus or deficit of phosphate, potash or magnesium applied to previous crops.
8. Using the tables, decide on the required rate of each nutrient. Decide the optimum timings for fertiliser application, then find the best match for these applications using available fertilisers.
9. Check that the fertiliser spreader or sprayer is in good working order and has been recently calibrated (**Section 1: Principles of nutrient management and fertiliser use**).
10. Keep an accurate record of the fertilisers and organic materials applied.

Further information

Soil management
ahdb.org.uk/greatsoils

Simply Sustainable Soils
leafuk.org/leaf/farmers/simplysustainablesoils

Identification of soil category

Careful identification of the soil category in each field is very important. The whole soil profile should be assessed to rooting depth. Where the soil varies, and nitrogen is to be applied uniformly, select the soil type that occupies the largest part of the field.

The soil category can be identified using Figure 7.1 which categorises soils on their ability to supply and retain mineral nitrogen. The initial selection can then be checked using Table 7.1.

Carefully assess the soil organic matter content when deciding if the soil is organic (10–20% organic matter for the purposes of this guide) or peaty (more than 20% organic matter). If necessary, seek professional advice on soil-type assessments, remembering this will need to be done only once.

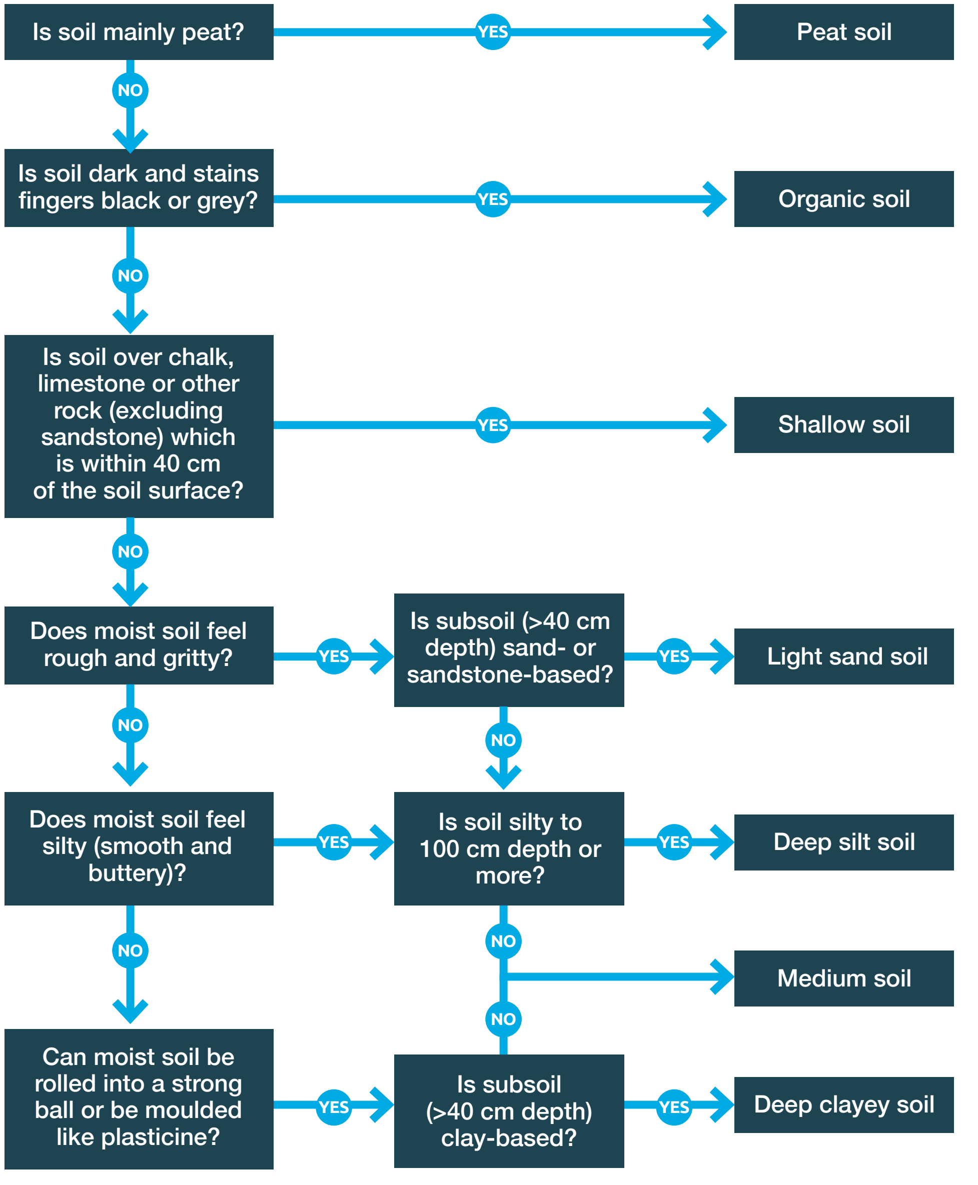

Figure 7.1 Soil category assessment

Table 7.1 Soil category assessment

Soil category	Description of soil types within category	Properties
Light sand soils	Soils that are sand, loamy sand or sandy loam to 40 cm depth and are sand or loamy sand between 40–80 cm, or over sandstone rock.	Soils in this category have poor water-holding capacity and retain little nitrogen.
Shallow soils	Soils over impermeable subsoils and those where the parent rock (chalk, limestone or other rock) is within 40 cm of the soil surface. Sandy soils developed over sandstone rock should be regarded as light sand soils.	Soils in this category are less able to retain or supply nitrogen at depth.
Medium soils	Mostly medium-textured mineral soils that do not fall into any other soil category. These includes sandy loams over clay, deep loams and silty or clayey topsoils that have sandy or loamy subsoils.	Soils in this category have moderate ability to retain nitrogen and allow average rooting depth.
Deep clayey soils	Soils with predominantly sandy clay loam, silty clay loam, clay loam, sandy clay, silty clay or clay topsoil overlying clay subsoil to more than 40 cm depth. Deep clayey soils normally need artificial field drainage.	Soils in this category are able to retain more nitrogen than lighter soils.
Deep silty soils	Soils of sandy silt loam, silt loam or silty clay loam textures to 100 cm depth or more. Silt soils formed on marine alluvium, warp soils (river alluvium) and brickearth soils are in this category. Silty clays of low fertility should be regarded as other mineral soils.	Soils in this category are able to retain more nitrogen than lighter soils and allow rooting to greater depth.
Organic soils	Soils that are predominantly mineral but with between 10–20% organic matter to depth. These can be distinguished by darker colouring that stains the fingers black or grey.	Soils in this category are able to retain more nitrogen than lighter soils and have higher nitrogen mineralisation potential.
Peat soils	Soils that contain more than 20% organic matter derived from sedge or similar peat material.	Soils in this category have very high nitrogen mineralisation potential.

Phosphate, potash and magnesium recommendations

For soil-grown crops, the current phosphate, potash and magnesium recommendations are based on achieving and maintaining target Soil Indices. Soil analysis should be done before planting and every 3–5 years in established crops. The use of soil analysis as a basis for making fertiliser decisions and the procedure for taking soil samples is described below.

The phosphate and potash recommendations given in the tables are sufficient to replace the crop offtake of established crops at the target Soil Index and, therefore, to maintain the target Soil Index. The amount of phosphate and potash needed to supply maintenance needs will depend on crop uptake and nutrient offtake. Where the soil is below the target phosphate or potash Index, the recommendations given in the tables are higher, to allow the soil to 'build up' to the target Index over time.

When the soil also needs liming, magnesium can often be supplied cost-effectively by using magnesian limestone. When liming is not required, a magnesium fertiliser should be used. Where magnesium deficiency has been diagnosed, foliar sprays of agricultural magnesium sulphate (Epsom salts) or other proprietary materials are likely to give a more rapid effect than a soil application of a magnesium fertiliser.

Points to consider

- Recommendations assume good soil structure, water supply and pest and disease control
- Recommendations are given as phosphate (P_2O_5), potash (K_2O) and magnesium oxide (MgO). Conversion tables (metric–imperial, oxide–element) are given on page 25
- Organic materials supply phosphate and potash, which contribute to crop requirements. Don't forget to make allowance for the phosphate and potash applied in organic materials (**Section 2: Organic materials**)
- All recommendations are given for the midpoint of each Index. Where a soil analysis value (as given by the laboratory) is close to the range of an adjacent Index, the recommendation may be reduced or increased slightly, taking account of the recommendation given for the adjacent Index. Small adjustments of less than 10 kg/ha are generally not justified
- Where more or less phosphate and potash are applied than suggested in the tables, adjustments can be made later in the rotation

Taking soil samples for pH, phosphate, potassium and magnesium

Soil sampling must be done well to avoid misleading results and expensive mistakes.

- The soil in each field should be sampled before planting and every 3–5 years thereafter
- Ideally, samples should be collected in the spring
- Do not sample within six months of a lime or fertiliser application (except nitrogen) and avoid sampling when the soil is very dry
- Do not take samples in headlands or in the immediate vicinity of hedges, trees or other unusual features
- Before planting, samples should be collected before ploughing so that if lime and/or fertiliser is needed, it can be applied and then ploughed down
- The soil sample must be representative of the area sampled. Areas of land known to differ in some important respects (e.g. soil type, previous cropping, applications of manure, fertiliser or lime) should be sampled separately
- Small areas known to differ from the majority of a field should be excluded from the sample
- Before planting in old herbicide strip orchards, separate samples should be taken from the grass alley and the strip, especially where previous lime and fertiliser applications have been applied to the strip only

- Established orchards in overall grass management, or very weedy orchards, should be sampled within the spread of the tree branches
- In established orchards with herbicide strip management, sampling should be restricted to the strip, excluding the grass area
- Samples from soft fruit plantations and hops should be taken from within the area of rooting
- Clean tools before starting and before sampling a new area
- Walk a ‘W’ pattern across the sampling area, stopping at least 25 times
- At each point, collect a subsample (core) using a gouge corer or screw auger
- Fields intended for planting should be sampled to a depth 0–15 cm and 15–30 cm, this is particularly important on land previously in fruit, vines, hops or grass where a depth gradient in nutrient content and acidity will probably have developed
- The 15–30 cm sample is not essential on land that has been ploughed regularly to a depth of 25 cm or more
- For all established crops, sample to 15 cm depth
- An even depth of sampling is important and, when necessary, both the top and bottom portions of the soil core should be included in the subsample
- The subsamples should be bulked to form a representative sample and sent to the laboratory for analysis. As a rule of thumb, take one bulk sample for every 4 hectares of land under the same management
- Use appropriate packaging (normally available from the laboratory) and label samples clearly, providing as much information about the field and crop as possible

Classification of soil analysis results into Indices

The laboratory soil analysis results for P, K and Mg (in mg/kg dry soil) can be converted into Soil Indices using Table 7.2.

Table 7.2 Classification of soil P, K and Mg analysis results into Indices

Index	Phosphorus (P)	Potassium (K)	Magnesium (Mg)
	mg/litre		
	Olsen P	Ammonium nitrate extract	
0	0–9	0–60	0–25
1	10–15	61–120	26–50
2	16–25	121–240	51–100
3	26–45	241–400	101–175
4	46–70	401–600	176–250
5	71–100	601–900	251–350
6	101–140	901–1,500	351–600
7	141–200	1,501–2,400	601–1,000
8	201–280	2,401–3,600	1,001–1,500
9	Over 280	Over 3,600	Over 1,500

Soil acidity and liming

Most fruit crops are tolerant of slight acidity and grow best at around pH 6.0–6.5. Soil pH levels below about 5.5 can give rise to manganese toxicity, causing 'measley' bark in apples and purple veining in some strawberry varieties. Blackcurrants are more susceptible to soil acidity and a pH of at least 6.5 should be maintained.

Blueberries are an exception to other fruit, as they require a soil pH of 4.5–5.5. Where soil pH is higher than this, ammonium sulphate can be used to lower the pH, providing the soil does not contain free calcium carbonate.

Mature hops can tolerate a considerable degree of soil acidity, but some varieties may suffer from manganese toxicity if the soil becomes too acidic. Young hop plants are more sensitive to acidity.

It is important that soils used for fruit, vines and hops are not over-limed as this may lead to micronutrient deficiencies, such as iron and manganese.

Liming before planting

Any lime required should be applied and incorporated before planting, see Section 1: Principles of nutrient management and fertiliser use. Because acidity problems occur in patches and acidity can develop rapidly when herbicides are used, the whole plough layer should be limed to maintain a pH value of 6.5 in the early years of fruit or hops. It will be impossible to correct any acidity at depth by later lime incorporation, so the quantity of lime applied before planting should be calculated to correct the pH of the top 40 cm of soil.

Where lime is needed to correct acidity in the subsoil, it should be ploughed down. Where sampling has only been carried out to 15 cm depth, the lime requirement using this pH result should be doubled. If the total lime requirement is more than 7.5 t/ha, half should be deeply cultivated into the soil and ploughed down, with the remainder applied and worked in after ploughing. If less than 7.5 t/ha of lime is needed, the whole requirement should be applied after ploughing and cultivated in.

On soils where acidity is known to occur, soil may need to be tested more frequently than the four-year cycle used for phosphate, potash and magnesium. Since acidity can occur in patches, spot testing with a soil indicator across the field is often useful. Soil indicators can also be useful on soils which contain fragments of free lime, since these can give a misleadingly high pH when analysed following grinding in the laboratory.

Where there is significant variability of soil pH, lime should be applied at different rates in different areas so that the whole field reaches the same pH. If testing with a coloured indicator, or a pH meter shows that the soil pH is less than 5.0 below plough depth, seek further advice before liming or planting.

Liming established crops

Under herbicide strip management, the strip will generally become acidic more quickly than the grass alley and may require more frequent liming than the alley. The correction of acidity in undisturbed soil is slow, so it is important to check soil pH regularly and apply lime when necessary before the soil becomes too acidic and a severe problem builds up.

Liming materials

Acidic soils deficient in magnesium may be limed with magnesian limestone, particularly before planting. One tonne of magnesian limestone contains at least 150 kg MgO. However, over-application of magnesian limestone can reduce the availability of soil potash. Where soil magnesium levels are satisfactory, ground chalk or limestone should be used. The use of coarse grades of limestone or chalk should be avoided.

See Section 1: Principles of nutrient management and fertiliser use for more information on liming rates.

Sulphur recommendations

Fruit crops are not generally thought to respond to sulphur. However, atmospheric sulphur emissions have declined significantly and a yield response to sulphur is possible in some circumstances. Where sulphur deficiency has been recognised or is expected, apply 15–25 kg/ha SO_3. Sulphur should be applied as a sulphate-containing fertiliser in the spring. Crops are most at risk of sulphur deficiency where they are grown on light sandy soils, soils with a low organic matter content and in high rainfall areas.

Points to consider

- Recommendations are given as sulphur trioxide (SO_3). Conversion tables (metric–imperial, oxide–element) are given on page 25
- Organic materials supply crop-available sulphur, which contributes to crop requirements
- Don't forget to make allowances for the crop-available sulphur applied in organic materials (**Section 2: Organic materials**)
- Further guidance on sulphur can be found in **Section 1: Principles of nutrient management and fertiliser use**

Micronutrients recommendations

Micronutrient deficiencies may occur in fruit, vine and hop crops, especially where the soil pH is over 7.0. These deficiencies can often be identified by visual symptoms, but the diagnosis should be checked by leaf analysis. Iron deficiency cannot reliably be confirmed by leaf analysis.

- Boron (B): boron deficiency in fruit crops is uncommon but can occur in hot dry summers, with pears being most susceptible. Where confirmed, the deficiency can be corrected by foliar application of boron
- Copper (Cu): copper deficiency in pears has been diagnosed on occasion, particularly in orchards on sandy soils. It can be corrected by applying a foliar spray of copper
- Iron (Fe): iron deficiency occurs commonly in fruit crops grown on shallow, calcareous soils. Either soil or foliar application of a suitable iron chelate can be used for treatment
- Manganese (Mn): manganese deficiency can occur in fruit crops grown on calcareous soils or soils with a high pH. It is best controlled by foliar application of manganese
- Zinc (Zn): zinc deficiency has very occasionally been found to reduce growth and cropping of apple trees on sandy soils. This deficiency can be corrected by foliar application of zinc, but applying excessive amounts during blossom or cell division may decrease the number of fruitlets

Fruit, vines and hops – before planting

Nitrogen is not required before planting fruit crops but can be beneficial before planting potted hop cuttings. Where soil analysis before planting shows soil acidity or low soil P, K or Mg Indices, it is important to correct these shortages by thorough incorporation of appropriate amounts of lime and fertilisers.

After planting, the downward movement of all nutrients from the soil surface is slow, except for nitrogen. This applies particularly for phosphate and to a lesser extent for potash and magnesium. In organic production systems, soil fertility must be built up prior to planting.

Where previously ploughed land has been sampled to 15 cm depth only, the recommended amounts of phosphate, potash and magnesium should be thoroughly incorporated in the autumn before planting. Before planting top fruit, vines or hops, if soil analysis shows the field to be at P, K or Mg Index 0 or 1, the appropriate nutrient quantities should be ploughed down. Then the same amount of nutrients should be applied again and thoroughly incorporated before planting. If the plough depth is less than 20 cm, the amount ploughed down should be halved.

Where samples have been taken from 0–15 cm and 15–30 cm depths, the recommended rate based on the 15–30 cm sample should be ploughed down before top fruit, vines or hops are planted, if the soil P, K or Mg Index is 0 or 1. After ploughing, the amount based on the 0–15 cm sample should be applied and thoroughly incorporated. If the plough depth is less than 20 cm, the amount ploughed down should be halved.

Where it is not possible to plough fertiliser down, the application should be limited to the amount recommended for one sampling depth only. Composted green waste and green manure crops can be incorporated to increase soil organic matter content.

Table 7.3 Nitrogen, phosphate, potash and magnesium for fruit, vines and hops before planting

Nutrient	SNS, P, K or Mg Index[a]					
	0	1	2	3	4	5 and over
	kg/ha					
Fruit and vines						
Nitrogen (N)	0	0	0	0	0	0
Phosphate (P_2O_5)	200	100	50	50	0	0
Potash (K_2O)[b]	200	100	50	0	0	0
Magnesium (MgO)	165	125	85	0	0	0
Hops						
Nitrogen (N)[c]	0	0	0	0	0	0
Phosphate (P_2O_5)	250	175	125	100	50	0
Potash (K_2O)[b]	300	250	200	150	100	0
Magnesium (MgO)	250	165	85	0	0	0

a. The recommendations in Table 7.3 are based on samples taken from a 15 cm depth of soil.

b. Apply potash in the autumn and thoroughly incorporate it into the soil to avoid root scorch of the newly planted crop.

c. Potted hop plants benefit from 70–80 kg N/ha applied in the spring before planting.

Points to consider

- Make allowance for nutrients applied in organic materials (**Section 2: Organic materials**)

Top fruit, established orchards

Nitrogen recommendations are based on the soil management system and soil type. The recommendations are intended as a guide and should be varied according to variety, rootstock, vigour, leaf or fruit analysis and appearance of foliage.

Nitrogen dressings can be split across the growing season. The largest demand for nitrogen is between blossom and late July, which corresponds with the rapid shoot growth phase, and nitrogen applications should reflect this. No application should be made during or after leaf drop.

The results of leaf and fruit analysis are particularly important. The width of the herbicide strip, the effectiveness of the herbicide programme and use of mulches (e.g. straw) can also influence nitrogen requirements. Straw and composted green waste mulches release potash, which can antagonise calcium uptake. In extreme cases, this can cause physiological fruit disorders, where soil calcium availability is low. Guidance on the use of leaf and fruit analysis to modify recommendations is given on pages 19 and 22, respectively.

Applying excess nitrogen encourages vegetative growth, causing large, dark green leaves. This may adversely affect fruit quality, especially taste, firmness and storage quality. Increasing nitrogen reduces the amount of red colour and intensifies the green colour of apples. This effect is detrimental to crop appearance and value in red-coloured varieties but can be beneficial in culinary varieties such as Bramley. Excess nitrogen can also reduce the storage life of fruit. However, autumn foliar application of nitrogen can improve blossom quality in the following spring.

When nitrogen is deficient, the leaves of fruit crops tend to be small and pale green, the bark of fruit trees may be reddish in colour and shoot growth restricted. Yields are reduced due to the decrease in the number and size of fruit, which may also be highly coloured.

In grass alley herbicide strip orchards, the tree roots are largely confined to the strip and fertiliser should be applied to the herbicide strip only. The nutrient recommendations given in Table 7.4 are for the complete orchard area and can be reduced where nitrogen is applied to the bare soil area only.

Further information

Apple Best Practice Guide
apples.ahdb.org.uk

Fertigation of young trees

The addition of nutrients to the irrigation water (fertigation) can improve the growth and nutrient use efficiency of trees.

Fertigation may be particularly beneficial for early cropping of young apple trees planted on sites previously cropped with apples and may help overcome replanting problems. A benefit is more likely where the soil organic matter level and nitrogen reserves have been depleted by long-term use of herbicides, intended to maintain a bare soil surface.

The rate of nitrogen addition should be about 10 g N/tree in the first growing year, increasing to 15–20 g N/tree in the second and third years. Fertigation will allow fertiliser rates to be reduced by up to 50% of that used for broadcast applications in orchards older than three years. It can also help correct nutrient deficiencies, such as phosphate, because nutrients in solution are more rapidly moved down the soil profile. Again, leaf analysis should be used regularly to provide feedback on adjusting nutrition to appropriate levels.

Points to consider

- Care should be taken to ensure soils are not completely wetted, to minimise the risk of nitrate leaching

Table 7.4 Nitrogen for established top fruit

Soil category	Grass/herbicide strip[a]	Overall grass
	kg N/ha	
Dessert apples[b]		
Light sand and shallow soils	80	120
Deep silty soils	30	70
Clays	40	80
Other mineral soils	60	100
Culinary and cider apples		
Light sand and shallow soils	110	150
Deep silty soils	60	100
Clays	70	110
Other mineral soils	90	130
Pears, cherries and plums		
Light sand and shallow soils	140	180
Deep silty soils	90	130
Clays	100	140
Other mineral soils	120	160

a. In grass alley/herbicide strip orchards, the tree roots are largely confined to the strip and fertiliser can be applied to the herbicide strip only. The nitrogen recommendations given here are for the complete orchard area and can be reduced where nitrogen is applied to the herbicide strip area only. Nitrogen rates can also be adjusted depending on plant vigour and the results of leaf nitrogen analysis.

b. Larger nitrogen rates may be needed on varieties with regular heavy cropping potential (i.e. >40 t/ha).

Table 7.5 Phosphate, potash and magnesium for established top fruit

Nutrient	P, K or Mg Index				
	0	1	2	3	4 and over
	kg/ha				
All top fruit, annually					
Phosphate (P_2O_5)	80	40	20	20	0
Potash (K_2O)[a]	220	150	80	0	0
Magnesium (MgO)	100	65	50	0	0

a. Pears require approximately an additional 70 kg K_2O/ha up to Index 3 but no addition at Index 4. Cider apples also respond to larger application rates of potash.

For apples, soil K Index should not be built up above 2 because excessively large potash applications can adversely affect storage quality. To avoid inducing magnesium deficiency, the soil K:Mg ratio (based on soil mg/litre K and Mg) should be no greater than 3:1. Where the yields of apples and pears are regularly above 40 t/ha, maintenance applications of potash may need to be increased by 20 kg K_2O/ha for every additional 10 t/ha in yield.

For established crops, the timing of phosphate, potash and magnesium application is not critical. If the nutrient Index is 2 or over, the nutrients may be applied at twice the recommended rate every second year.

Points to consider

- Make allowance for nutrients applied in organic materials (**Section 2: Organic materials**)

Soft fruit and vines, established plantations

For bush and cane fruits, nitrogen rates may need to be modified depending on the amount of annual growth required for a particular production system. When nitrogen is deficient, leaves tend to be small and pale green.

For blackcurrants, apply nitrogen in two or three applications, either split across three approximately equal applications timed for late-dormant, May and post-harvest, or apply 66% at leafing-out and the remainder post-harvest.

The nitrogen recommendations for raspberries are for both floricane and primocane varieties. For floricane varieties, nitrogen should be applied between the onset of floricane growth and the end of July. Avoid applying nitrogen after the end of July to avoid excessive growth of soft cane, unless nitrogen is applied at lower rates through fertigation, where nitrogen applications may continue until the end of August.

For primocane varieties, nitrogen should be applied between emergence and early October. Avoid applying nitrogen after the beginning of October to avoid excessive growth of soft cane.

For crops that are establishing prior to reaching full crop potential, smaller rates of nitrogen are usually adequate. The rate should be adjusted according to the amount of growth required and the results of leaf nitrogen analysis.

Points to consider

- Under Nitrate Vulnerable Zone (NVZ) rules, no fertiliser nitrogen should be applied to field-grown crops during the closed period, unless supported by written advice from a FACTS Qualified Adviser

Table 7.6 Nitrogen for soft fruit and vines

Soil category	Soft fruit and vines
	kg/ha
Blackcurrants[a,b]	
Light sand and shallow soils	160
Deep silty soils	110
Clays	120
Other mineral soils	140
Redcurrants, gooseberries, raspberries, loganberries, tayberries, blackberries[a]	
Light sand and shallow soils	120
Deep silty soils	70
Clays	80
Other mineral soils	100
Vines[c]	
Light sand and shallow soils	60
Deep silty soils	0
Clays	20
Other mineral soils	40

a. With continuing change in varieties, adjust nitrogen rates depending on plant vigour.

b. For blackcurrants, varieties developed by James Hutton Ltd in the ‘Ben’ series typically require 70–120 kg N/ha. Higher nitrogen rates may reduce fruit quality for processing.

c. Excessive growth of vines will cause wood to ripen slowly and a yield reduction in the following crop. Reduce nitrogen rates where growth is excessive.

Table 7.7 Phosphate and potash for soft fruit and vines

Nutrient	P, K or Mg Index				
	0	1	2	3	4 and over
	kg/ha				
Blackcurrants, redcurrants, gooseberries, raspberries, loganberries, tayberries					
Phosphate (P_2O_5)	110	70	40	40	0
Potash (K_2O)[a]	250[a]	180[a]	120	60	0
Blackberries and vines					
Phosphate (P_2O_5)	110	70	40	40	0
Potash (K_2O)[a]	220	150	80	0	0
All crops					
Magnesium (MgO)[b]	100	65	50	0	0

a. Sulphate of potash should be used for raspberries, redcurrants and gooseberries where more than 120 kg K_2O/ha is applied.

b. To avoid inducing magnesium deficiency, the soil K:Mg ratio (based on soil mg/litre K and Mg) should be no greater than 3:1. For established crops, the timing of phosphate, potash and magnesium applications is not critical.

Points to consider

- Make allowance for nutrients applied in organic materials (**Section 2: Organic materials**)
- Under NVZ rules, no fertiliser nitrogen should be applied to field-grown crops during the closed period, unless supported by written advice from a FACTS Qualified Adviser

Table 7.8 Nitrogen for soil-grown strawberries

Soil category	SNS Index					
	0	1	2	3	4	5 and over
	kg N/ha					
Strawberries – main season						
Light sand and shallow soils	60	50	40	30	20	0
Deep silty soils	0	0	0	0	0	0
Other mineral soils	40	40	30	20	0	0
Strawberries – everbearers						
Light sand and shallow soils	80	70	60	40	20	0
Deep silty soils	40	30	30	20	0	0
Other mineral soils	60	50	40	20	0	0

Nitrogen recommendations for strawberries are based on the Soil Nitrogen Supply (SNS) Index. For information on determining the SNS Index, refer to **Section 6: Vegetables and bulbs**. With continued change in varieties, adjust nitrogen rates depending on plant vigour and the results of leaf analysis.

Table 7.9 Phosphate, potash and magnesium for soil-grown strawberries

Nutrient	P, K or Mg Index				
	0	1	2	3	4 and over
	kg/ha				
Phosphate (P_2O_5)	110	70	40	40	0
Potash (K_2O)	220	150	80	0	0
Magnesium (MgO)[a]	100	65	50	0	0

a. To avoid induced magnesium deficiency, the soil K:Mg ratio (based on soil mg/litre K and Mg) should be no greater than 3:1.

Fertigation

Where strawberries or raspberries are grown under a polythene mulch with subirrigation, nutrients can be applied in the irrigation system (fertigation). On soils that encourage vigorous growth, it may be beneficial to reduce nitrogen rates when applied by fertigation. Where growth is not excessive, the nitrogen rates for the whole season should be the same as those recommended for soil applications but with less being applied during the fruiting period.

At P and K Index 2 or above, maintenance rates of phosphate and potash can be applied by fertigation. However, where the soil P, K or Mg Index is 0 or 1, the recommended amounts of phosphate and potash should be cultivated into the planting bed before the soil is mulched. Irrigation water may also contain nutrients, particularly calcium, and care should be taken when mixing with fertiliser as insoluble compounds may form, which can block emitters.

Points to consider

- Make allowance for nutrients applied in organic materials (**Section 2: Organic materials**)

Substrate strawberry production

When strawberries are grown in an inert substrate, a complete nutrient solution is required. Table 7.10 provides guidelines for the normal range of nutrients in solution. Normally, a conductivity of 1.4 mS/cm is maintained during growth and production for main crop ‘June bearers’ and the value should not exceed 2.0 mS/cm.

High salinity can cause marginal necrosis and stimulate leaf and flower-tip burn. During vegetative growth, the substrate K:Ca ratio (based on mg/litre K and Ca) should be maintained at 0.65, and at 0.7–0.8 during flowering and fruiting to improve fruit taste and firmness.

Plants grown on substrates are very sensitive to excessive concentrations of zinc, boron and sodium in the nutrient solution. Deficiency of iron and manganese can occur at high (alkaline) pH levels in the substrate.

The nutrients will need to be adjusted depending on whether peat or coir substrates are used. Coir is usually supplied unfertilised and therefore needs wetting up for 2–3 days before planting with a feed solution. It needs more calcium, magnesium and sulphur but less boron and potassium when used fresh.

Owing to its inherently high pH, coir needs a lower solution pH (5.3–5.8) than for peat (5.6–6.0). Furthermore, feed recipes also depend on the chemical composition of the irrigation water and should be modified during the growing season according to the results of substrate, leaf tissue and drainage solutions analyses.

Careful scheduling of irrigation will help to improve water and nutrient use efficiencies. Recent work has shown savings of 10–20% where irrigation is scheduled to match demand with supply. Monitor substrate moisture content to establish which irrigation events can be reduced to save water and fertiliser.

Table 7.10 Guidelines for nutrient solution for strawberry production on substrate

Nutrient	Normal range
	mg/litre
Nitrogen (NO3)	110–140
Nitrogen (NH4)	7–14
Phosphorus (P)	46
Potassium (K)	140–250
Magnesium (Mg)	30–40
Calcium (Ca)	140–180
Sulphate (SO4)	50–100
Iron (Fe)	1.1–1.7
Zinc (Zn)	0.46–0.65
Boron (B)	0.11–0.17
Manganese (Mn)	0.55–1.11
Copper (Cu)	0.03
Molybdenum (Mo)	0.05

Further information

Principles of strawberry nutrition in soilless substrates
ahdb.org.uk/knowledge-library/principles-of-strawberry-nutrition-in-soilless-substrates

Understanding and measuring conductivity in soilless substrate grown soft fruit crops
ahdb.org.uk/knowledge-library/understanding-and-measuring-conductivity-in-soilless-substrate-grown-soft-fruit-crops

Strawberry analysis chart – optimum ranges
ahdb.org.uk/knowledge-library/strawberry-analysis-chart

Leaf analysis for top and soft fruit

Leaf analysis is an essential technique for general monitoring of nutrient status and the diagnosis of nutritional disorders. Separate samples should be taken in a similar manner from good and poor areas of growth so that the results can be compared.

In addition, knowledge of leaf nutrient concentrations has proved useful for assessing the nutritional status of crops. Satisfactory ranges for optimal growth and cropping are given in Tables 7.11, 7.12 and 7.13. Where analysis results are to be compared with these standards, it is essential that a representative sample is taken in the correct way and at the correct time.

Because there are seasonal and other factors that influence leaf nutrient concentrations, leaf analysis must be interpreted carefully. Leaf nutrient levels can also vary between varieties. Where there is sufficient information, the standard ranges take account of differences between varieties.

Leaf analysis can be used to provide a more complete indication of the adequacy of the orchard fertiliser programme than can be obtained from soil analysis alone. Where leaf nutrient levels are below the satisfactory range, an increase in fertiliser use can be considered. However, before making a change, the cause of the problem should be further investigated to ensure that other factors, such as soil compaction or disease, are not involved.

Where the leaf nutrient level is consistently above the satisfactory range for several years, there is justification for a reduction in fertiliser use. In particular, high levels of nitrogen and potash can have adverse effects on apple storage quality and application rates can often be reduced.

A high manganese level indicates a need to check soil pH as it is often associated with increased soil acidity but can also result from use of foliar feeds or fungicides containing manganese.

Table 7.11 Leaf analysis – nutrient ranges of major nutrients expressed as elements

Crop	Leaf sampling position[a]	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Sulphur (S)
		% in dry matter				
Apples – Cox[b]	1	2.6–2.8	0.20–0.25	1.2–1.6	0.20–0.25	0.20–0.40
Apples – Bramley	1	2.4–2.8	0.18–0.23	1.2–1.6	0.20–0.30	–
Cherries	1	2.4–2.8	0.20–0.25	1.5–2.0	0.20–0.25	0.13–0.84
Pears – Comice	1	1.8–2.1	0.15–0.20	1.2–1.6	0.20–0.25	0.17–0.26
Pears – Conference	1	2.1–2.6	0.15–0.20	1.2–1.6[c]	0.20–0.25	–
Plums	1	2.0–2.6	0.15–0.20	1.5–2.0	0.20–0.25	0.20–0.70
Blackcurrants	2	2.8–3.0	0.25–0.35	1.5–2.0	0.15–0.20	–
Raspberries	3	2.4–2.8	0.20–0.25	1.5–2.0	0.30–0.35	–
Soil-grown strawberries	4	2.6–3.0	0.25–0.30	1.5–2.0	0.15–0.20	0.10–0.20
Vines	5	2.0–3.0	0.25–0.30	1.2–1.6	0.20–0.30	–
Blueberries	6	1.8–2.0	0.08–0.40	0.4–0.7	0.13–0.25	0.12–0.20

a. Leaf sampling position:
   1. Mid third extension growth, sampled mid–late August.
   2. Fully expanded leaves extension growth, sampled prior to harvest.
   3. Fully expanded leaves non-fruiting canes, sampled at fruit ripening.
   4. Lamina of recently matured leaves, sampled at fruit ripening.
   5. Leaf opposite basal fruit cluster, sampled at full bloom.
   6. Fully expanded leaves between late July and mid-August.

b. For Gala and Braeburn, follow Cox. However, the typical average for Gala is 2.3% N, and P content is less than in Cox.

c. Yield benefits are achieved at 1.6% K.

Table 7.12 Leaf analysis – nutrient ranges of micronutrients

Nutrient	Deficiency	Optimum	High
	mg/kg in dry matter		
Manganese (Mn)	20	30–100	100[a]
Boron (B)[b]	15	20–40	40[c]
Zinc (Zn)	10	15–30	50
Copper (Cu)	5	7–15	15
Iron (Fe)	<45	45–250	

a. Manganese concentrations above 100 mg Mn/kg indicate that the soil is becoming acidic. Check the soil pH.

b. Fruit analysis is the most reliable diagnostic technique for boron deficiency. Optimum levels are 1.5 to 4.5 mg B/kg fresh weight. Below 1.5 mg B/kg indicates deficiency.

c. Excess boron levels can promote premature ripening and senescence in fruit.

Further information

Principles of strawberry nutrition in soilless substrates
ahdb.org.uk/knowledge-library/principles-of-strawberry-nutrition-in-soilless-substrates

Understanding and measuring conductivity in soilless substrate grown soft fruit crops
ahdb.org.uk/knowledge-library/understanding-and-measuring-conductivity-in-soilless-substrate-grown-soft-fruit-crops

Strawberry analysis chart – optimum ranges
ahdb.org.uk/knowledge-library/strawberry-analysis-chart

Table 7.13 Leaf analysis – substrate-grown strawberries

Nutrient	Deficiency	Optimum	High	Notes
	% in dry matter			
Nitrogen (N)	<1.5	2.0–3.5		Deficiency causes small, yellow or reddish leaves and poor growth High levels can cause excessive growth
Phosphorus (P)		0.3–0.6		Deficiency causes small pale leaves, small fruit and lower yields
Potassium (K)		1.5–3.0		Deficiency causes poorer-flavoured fruit and brown leaf margins Excess levels limit Ca uptake and affect fruit firmness and colour
Magnesium (Mg)		0.3–0.5		Deficiency causes interveinal reddening of older leaves Excessive magnesium is not normally a problem but could reduce K uptake
Sulphur (S)		>0.01		
Calcium (Ca)		1.0–2.0		Deficiency causes tip-burn on the young leaves and soft fruit, particularly when associated with high K or Mg levels Excessive calcium is not normally a problem
Sodium (Na)			>0.1–0.3	Substrate-grown crops are most susceptible Excess causes scorch of petioles and sepals and yield reduction at higher levels Reduce by flushing with calcium nitrate solution
Chloride (Cl)			>0.5	Excess causes damage to roots and yield reduction, but level depends on climate, substrate and plant type Reduce by flushing with calcium nitrate solution
Nutrient	mg/kg in dry matter			
Boron (B)	<30	30–50	>65	Deficiency causes yellowed leaves and small, malformed fruit Excess causes leaf burn and, in extreme cases, sepal and calyx scorch
Copper (Cu)	<2	5–20	>25	Deficiency causes yellowed leaves, shoot die-back and small fruit Excess symptoms are not normally seen in substrate strawberries
Iron (Fe)	<45	50–200	>350	
Manganese (Mn)	<20	50–250	>250	Deficiency causes interveinal leaf yellowing, more diffuse than with Fe deficiency Deficiency can be due to poor root growth or high pH Excess symptoms are not normally seen in substrate strawberries
Molybdenum (Mo)	<0.3	0.5		Deficiency or excess symptoms are not normally seen in substrate strawberries
Zinc (Zn)	<20	20–65	>120	Deficiencies cause pale green leaves with narrow, concave blades – some authorities also report poorer-flavoured fruit Excess causes leaf scorch and reduces Fe uptake

Apple fruit analysis

Analysis of fruit sampled within three weeks of picking is a useful indicator of the risk of some physiological disorders in stored apples. Results can also be used to rank orchards for potential storage quality. During the period between sampling for analysis and harvesting the fruit, the concentration of calcium falls mainly due to dilution as fruit size increases. Analysing fruit too far in advance of harvest may overestimate the storage potential.

- Fruit samples should be taken as near to harvest as possible but within two weeks of picking
- In each orchard, randomly select at least 20 trees of the same age and variety
- Take one apple at random from each tree, alternating from side to side and at different heights, but ignore abnormally large or small fruits
- Try to make the sample representative of the side of trees where most fruit is growing
- Place the 20 apples in a clean polythene bag and label clearly to indicate cultivar, orchard, farm and sampling date
- If areas of the orchard have been managed differently, for example as regards soil or tree management or there are areas differing in terms of growth and cropping, then these should be sampled separately
- It may be necessary to segregate sections of the orchard at picking time and to allocate the fruit to different stores based on the indicated storage potential

If fruit analysis produces consistently high or low concentrations of a particular nutrient over 2–3 years, modification of fertiliser application should be considered. The most likely change will be a reduction in nitrogen or potash use. Fruit analysis may also show deficiencies of calcium or phosphorus, which can reduce fruit storage quality. These deficiencies can be corrected by foliar sprays of calcium and phosphorus or by post-harvest calcium treatments.

Further information

Apple Best Practice Guide

apples.ahdb.org.uk

Table 7.14 Average nutrient concentrations in Cox, Bramley and Gala apples (sampled at harvest)

Crop	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Calcium (Ca)
	mg/100 g fresh weight				
Cox	50–70	11.0 minimum	130–150	5.0	4.5 minimum[a] 5.0 minimum[b]
Bramley	60 maximum	9.0 minimum	105–115	5.0	4.5 minimum[a] 5.0 minimum[b]
Gala	42	9.3	122	5.0	7.4

a. For controlled-atmosphere storage (Cox in 2% oxygen until late February or 1.2% oxygen until late March; Bramley in 8–10% carbon dioxide until June or 5.0% carbon dioxide plus 1.0% oxygen until July).

b. For storage in air at recommended temperature (Cox until mid-October; Bramley until November).

Satisfactory nutrient concentrations have been established for Cox, Bramley and Gala apples at harvest (Table 7.14) and for Gala and Braeburn to weeks prior to harvest (Table 7.15). The standards given for calcium and potassium concentrations in Cox also apply to Egremont Russet.

Table 7.15 Average nutrient concentrations in Gala and Braeburn apples (sampled two weeks prior to harvest)

Crop	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Calcium (Ca)
	mg/100 g fresh weight				
Gala	45	10.2	106	5.3	9.6
Braeburn	52	11.9	102	5.1	6.3

- Gala is naturally low in P compared with Cox, but this does not affect storage potential
- Gala is naturally high in Ca and does not suffer from Ca-dependent storage disorders
- Large concentrations of K in Gala fruit may increase the risk of breakdown
- Gala fruits higher in Ca and lower in K may be firmer ex-store
- Braeburn has a similar composition to Cox, except that K concentration appears lower
- Cox calcium threshold concentrations may be used to judge the storage potential of Braeburn apples

Nitrogen (N) – as the nitrogen content increases, fruit becomes more susceptible to rotting, loss of firmness, poor skin finish and a lack of red colour. Above 80 mg N/100 g the risk of disorders in Cox is high. In Bramley, a large nitrogen concentration leads to more green colour but with a risk of lower firmness.

Phosphorus (P) – at phosphorus contents below 11 mg P/100 g in Cox, there is an increased risk of fruit losing firmness and developing breakdown, particularly if calcium is also low. In Bramley, the phosphorus threshold for breakdown is lower at 9 mg P/100 g.

Potassium (K) – a high potassium content will increase the risk of bitter pit, *Gloeosporium* rotting and core flush. The risk of bitter pit is also greater if the calcium level is low in relation to potassium. Generally, fruit flavour and acidity increase with increasing levels of potassium. Thus, if calcium levels are adequate (over 5.5 mg Ca/100 g), large concentrations of potassium may be advantageous in terms of fruit quality.

Magnesium (Mg) – a high magnesium content will increase the risk of bitter pit, especially when calcium levels are marginal.

Calcium (Ca) – calcium levels of 5.0 mg Ca/100 g and above are necessary to maintain high quality throughout long-term storage. However, the storage potential will be modified depending on the content of other elements, especially potassium and phosphorus. Disorders associated with low calcium (bitter pit in particular) are more likely to occur in apples of a given calcium content that are stored in air rather than a controlled atmosphere. Thus, fruit which meets the standards for nitrogen, phosphorus, potassium and magnesium and has a calcium concentration in the range of 4–5 mg Ca/100 g should not be rejected for mid-term controlled-atmosphere storage, as it is unlikely to develop commercially significant levels of bitter pit or breakdown. This much lower risk is reflected by the dual standards for calcium given in the table.

The risk of bitter pit and susceptibility to *Gloeosporium* will depend on the ratio of K:Ca. If the K:Ca ratio is over 30:1 in air-stored Cox or Bramley stored in controlled atmosphere, or over 25:1 in air-stored Bramley, commercially important losses due to bitter pit are likely. Where calcium contents are marginal (3.5–4.0 mg Ca/100 g) and fruit phosphorus is also less than 9.0 mg P/100 g, both Cox and Bramley are more susceptible to breakdown. In such cases, Cox should be marketed early. Bramley should be stored at a higher temperature (average 4.5°C) and sold earlier than fruit with optimum levels of calcium and phosphorus.

Gloeosporium risk is dependent on the level of inoculum in the orchard and is influenced by skin finish, fungicide programme and rainfall prior to harvest. Fruit analysis can give an indication of fruit susceptibility to *Gloeosporium* but not necessarily the eventual amount of rotting.

The incidence of senescent breakdown is greatest in late-picked fruit for any given content of phosphorus and calcium.

Susceptibility to low-temperature breakdown in Cox stored at 3.0°C (air) and 3.5°C (controlled atmosphere), although less common in Bramley at 4.0°C, is also partly due to low calcium and phosphorus contents.

Hops

See page 12 for pre-planting fertiliser recommendations. Fertiliser is not required in the establishment year, provided appropriate pre-planting fertilisers have been applied.

Table 7.16 Nitrogen in established hops (second and subsequent years after establishment)

Soil category	kg N/ha
Deep silty soils	180
Clay soils	200
Other mineral soils	220

The recommended rates are for maximum-yield situations and should be applied annually. Nitrogen can reduce the alpha-acid content of hop cones, though it may produce more alpha-acid per hectare because the crop yield is greater. Where progressive *Verticillium* wilt is present, high nitrogen rates will make hops more susceptible to this disease, so reduce the recommended amount to 125–165 kg N/ha where there is a risk of wilt.

Nitrogen should be split into two or three applications, the first dressing being given in late March or April, the second during May and the third in late June or early July. There is some evidence that late hop varieties, especially, respond to a three-timing split, with the last application no later than early July. The total rate should be adjusted according to variety, irrigation and soil type.

Where trickle irrigation is used, there is a benefit in using fertigation to apply nutrients.

Where large and frequent applications of organic manures have been used in previous years, reduce the nitrogen recommendation by 70 kg N/ha. Farmyard manure is best applied in the early summer to help minimise aggravating the effect of any wilt present, with alleyways treated in alternate years. Where organic manures have been applied in the previous 12 months, the nitrogen rate should be reduced according to the information in **Section 2: Organic materials**.

Table 7.17 Phosphate, potash and magnesium in established hops

Nutrient	P, K or Mg Index					
	0	1	2	3	4	5 and over
	kg/ha					
Phosphate (P_2O_5)	250	200	150	100	50	0
Potash (K_2O)	425	350	275	200	100	0
Magnesium (MgO)	150	100	50	0	0	0

Hops require the maintenance of large soil nutrient reserves, P Index 4, K Index 3 and Mg Index 2. Potash is important and care must be taken to ensure that the recommended rates are applied annually. To avoid induced magnesium deficiency, the soil K:Mg ratio (based on soil mg/litre K and Mg) should be no greater than 3:1.

Farmyard manure

Farmyard manure has been traditionally used on hops. As well as supplying nutrients, it helps to improve the structure of cultivated soils. Now that few soils growing hops are cultivated, there is less need for regular applications of bulky organic manures. Farmyard manure is recommended where the soil continues to be cultivated and where land is being prepared for planting.

Extreme caution should be exercised in the use of farmyard manure or slurry where *Verticillium* wilt is known, or suspected, to be present. Heavy applications of manure, in addition to supplying excess nitrogen, can reduce the soil temperature during the critical spring period. Low soil temperatures in the spring are known to make hops more susceptible to the disease.

Points to consider

- Make allowance for nutrients applied in organic materials (**Section 2: Organic materials**)

Conversion tables

Metric to imperial

1 tonne/ha	0.4 tons/acre
100 kg/ha	80 units/acre
1 kg/tonne	2 units/ton
10 cm	4 inches
1 m^3	220 gallons
1 m^3/ha	90 gallons/acre
1 kg/m^3	9 units/1,000 gallons
1 kg	2 units

Note: a 'unit' is 1% of 1 hundredweight, or 1.12lbs.

Imperial to metric

1 ton/acre	2.5 tonnes/ha
100 units/acre	125 kg/ha
1 unit/ton	0.5 kg/tonne
1 inch	2.5 cm
1,000 gallons	4.5 m^3
1,000 gallons/acre	11 m^3/ha
1 unit/1,000 gallons	
1 unit	0.5 kg

Element to oxide

P to P_2O_5	Multiply by 2.291
K to K_2O	Multiply by 1.205
Mg to MgO	Multiply by 1.658
S to SO_3	Multiply by 2.5
Na to Na_2O	Multiply by 1.348
Na to salt	Multiply by 2.542

Oxide to element

P_2O_5 to P	Multiply by 0.436
K_2O to K	Multiply by 0.830
MgO to Mg	Multiply by 0.603
SO_3 to S	Multiply by 0.4
Na_2O to Na	Multiply by 0.742
Salt to Na	Multiply by 0.393

Fluid fertiliser

kg/tonne (w/w basis) to kg/m^3
Multiply by specific gravity (w/v basis)

Glossary

Available (nutrient)	Form of a nutrient that can be taken up by a crop immediately or within a short period so acting as an effective source of that nutrient for the crop.
Calcareous soil	Soil that is alkaline due to the presence of free calcium carbonate or magnesium carbonate or both.
Clay	Finely divided inorganic crystalline particles in soils, less than 0.002 mm in diameter.
Closed period	Period of the year when nitrogen fertilisers or certain manures should not be applied unless specifically permitted. Closed periods apply within NVZs.
Compost	Organic material produced by aerobic decomposition of biodegradable organic materials.
Content (nutrient)	Commonly used instead of the more accurate ‘concentration’ to describe nutrients in fertiliser or organic manure. For example, 6 kg N/t often is described as the nitrogen content of a manure.
Cover crop	A crop sown primarily for the purpose of taking up nitrogen from the soil and which is not harvested. Also called green manure.
FACTS	UK national certification scheme for advisers on crop nutrition and nutrient management. Membership renewable annually. A FACTS Qualified Adviser has a certificate and an identity card.
Farmyard manure (FYM)	Livestock excreta that is mixed with straw bedding material that can be stacked in a heap without slumping.
Fertiliser	See Manufactured fertiliser.
Fluid fertiliser	Pumpable fertiliser in which nutrients are dissolved in water (solutions) or held partly as very finely divided particles in suspension (suspensions).
Green manure	See Cover crop.
Incorporation	A technique (discing, rotovating, ploughing or other methods of cultivation) that achieves some mixing between an organic manure and the soil. Helps to minimise loss of nitrogen to the air through volatilisation and nutrient run-off to surface waters.
Leaching	Process by which soluble materials such as nitrate or sulphate are removed from the soil by drainage water passing through it.
Lime requirement	Amount of standard limestone needed in tonnes/ha to increase soil pH from the measured value to a higher specified value (e.g. 6.5 for arable crops). Can be determined by a laboratory test or inferred from soil pH.
Livestock manure	Dung and urine excreted by livestock or a mixture of litter, dung and urine excreted by livestock, even in processed organic form. Includes FYM, slurry, poultry litter, poultry manure, separated manures, granular and pelletised manures.

Maintenance application (phosphate or potash) Amount of phosphate or potash that must be applied to replace the amount removed from a field at harvest (including that in any straw, tops or haulm removed).

Major nutrient Nitrogen, phosphorus and potassium that are needed in relatively large amounts by crops.

Manufactured fertiliser Any fertiliser that is manufactured by an industrial process. Includes conventional straight and NPK products (solid or fluid), organo-mineral fertilisers, rock phosphates, slags, ashed poultry manure and liming minerals that contain nutrients.

Manure See Livestock manure.

Micronutrient Boron, copper, iron, manganese, molybdenum and zinc, which are needed in very small amounts by crops (see also Major nutrients). Cobalt and selenium are taken up in small amounts by crops and are needed in human and livestock diets.

Mineral nitrogen Nitrogen in ammonium (NH_4) and nitrate (NO_3) forms.

Mineralisation Microbial breakdown of organic matter in the soil, releasing nutrients in crop-available, inorganic forms.

Nitrate vulnerable zones (NVZs) Areas designated by Defra as being at risk from agricultural nitrate pollution.

Offtake Amount of a nutrient contained in the harvested crop (including straw, tops or haulm) and removed from the field. Usually applied to phosphate and potash.

Olsen P Concentration of available P in soil determined by a standard method (developed by Olsen) involving extraction with sodium bicarbonate solution at pH 8.5. The main method used in England, Wales and Northern Ireland and the basis for the Soil Index for P.

Organic material (manure) Livestock manures and all other nitrogen-containing organic materials, such as sewage sludge, composts, food wastes, and organic wastes (treated and untreated).

Organic soil Soil containing between 10% and 20% organic matter (in this guide). Elsewhere, it sometimes refers to soils with between 6% and 20% organic matter.

Peat soil Soil containing more than 20% organic matter.

Run-off Movement of water across the soil surface, which may carry nutrients from applied organic materials or fertilisers and soil particles.

Sand Soil mineral particles larger than 0.05 mm.

Silt Soil mineral particles in the 0.002–0.05 mm diameter range.

Slurry Excreta of livestock (other than poultry), including any bedding, rainwater and washings mixed with it, that can be pumped or discharged by gravity. The liquid fraction of separated slurry is also defined as slurry.

SNS Index Soil Nitrogen Supply expressed in seven bands or Indices, each associated with a range in kg N/ha.

Soil Index (P, K or Mg)	Concentration of available P, K or Mg, as determined by standard analytical methods, expressed in bands or Indices.
Soil Nitrogen Supply (SNS)	The amount of nitrogen (kg N/ha) in the soil that becomes available for uptake by the crop in the growing season, taking account of nitrogen losses.
Soil organic matter	Often referred to as humus. Composed of organic compounds ranging from undecomposed plant and animal tissues to fairly stable brown or black material with no trace of the anatomical structure of the material from which it was derived.
Soil texture	Description based on the proportions of sand, silt and clay in the soil.
Soil type	Description based on soil texture, depth, chalk content and organic matter content.
Target Soil Index	Lowest soil P or K Index at which there is a high probability that crop yield will not be limited by phosphorus or potassium supply. See Soil Index (P, K or Mg).
Trace element	See Micronutrient.
Volatilisation	Loss of nitrogen as ammonia from the soil to the atmosphere.

Notes

Notes

Notes

Produced for you by:

AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

W ahdb.org.uk
@The_AHDB

For specific AHDB Nutrient Management Guide (RB209) enquiries:
T 024 7647 8784
E nutrient.management@ahdb.org.uk

To order printed publications:
T 0845 245 0009
E publications@ahdb.org.uk

70025 0221