TECHNICAL NOTE TN740 December 2020 • ELEC

Fertiliser recommendations for soft fruit and rhubarb crops

Farm Advisory Service

National Advice Hub
T: 0300 323 0161
E: advice@fas.scot
W: www.fas.scot

Summary

- **Soft fruit and rhubarb crops tend to be in the ground for several years. Problems of soil acidity and compaction should be addressed before planting since it will be much more difficult to do so once crops have been planted.**
- **Carry out soil analysis for pH, P, K and Mg before planting and every 3-5 years. Target soil values for soft fruit are pH 6.0-6.5 and upper moderate (M+) status for P, K and Mg.**
- **Tables that take account of nitrogen (N) released from previous crop residues, grass leys and N available from reserves in different soil categories have been updated.**
- **N recommendations take account of NVZ Action Programme rules and Nmax and will minimise losses of N to the environment.**
- **A soil specific approach to P management is presented that considers the relationship between differing soils capacity to regulate P availability for plant uptake.**

A. Lime and nutrient recommendations for crop establishment

Soft fruit and rhubarb crops tend to be in the ground for several years. Problems of soil acidity and compaction should be addressed before planting since it will be much more difficult to do so once crops have been planted. Compaction of the upper soil layers arising from trafficking wet soil can result in ponding of surface water and limits root development, restricts nutrient uptake, and reduces growth potential. Visual soil assessment is important to assess the extent and depth of compaction and to inform decisions on the most appropriate course of action. An SRUC field guide to identifying soil compaction provides detailed guidance on how to assess soil structure. If you have identified a compacted layer, you should consider cultivation to remove this compaction.

The soil in each field should be sampled before planting and every 3-5 years thereafter. Fields intended for planting should be sampled to a depth of about 25 cm. For all established crops, sample to 15 cm.

A1. Liming before crop establishment

Most fruit crops are tolerant of slight acidity and grow best at pH values of 6.0 – 6.5. Blackcurrants are less tolerant of soil acidity and pH values of at least 6.5 should be maintained. Blueberries are unusual, in that they require soil pH values of between 5.0 and 5.5 and as a result most of the UK blueberry crop is container grown. Because it will be impossible to correct any acidity at depth once fruit crops have been planted, the quantity of lime applied should be calculated so that it will correct the pH of the top 40 cm of soil.

Acid soils deficient in Mg may be limed with magnesian limestone before planting. Be aware that over-application of Mg can reduce the availability of soil K. Where soil Mg levels are satisfactory, ground limestone should be used (TN714, 2019) (www.fas.scot/publications/technical-notes/).

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TN740AD 12.20200

A2. Nitrogen (N) recommendations for new crops

To assess the N fertiliser requirements during the establishment phase for each crop, the following factors need to be considered:

Stage A2a:	Assessment of soil category	Table 1
Stage A2b:	Assessment of N residues taking account of the previous crop or previous grass/clover management	Tables 2, 3 and 4
Stage A2c:	Crop to be grown	Table 5
Stage A2d:	Adjustments for soil category/variety/production practices	
Stage A2e:	Adjustments for Winter rainfall	Table 6
Stage A2f:	Adjustments following applications of organic materials	

Adjustments to the standard fertiliser recommendations given for each crop considering the previous crop or previous grass/clover management should be made by following stages A2b to A2e. Specialist guidance may be needed when making decisions for specific crops.

Stage A2a. Assessment of soil category

The whole soil profile should be assessed to rooting depth. Where the soil varies and more than one category occurs within a field, it may be practical to alter the rate of fertiliser N to suit the different soil categories. If this is impractical, and the field is to be treated uniformly, you should select the soil category that covers the largest part of the field.

The soil category can be identified using Table 1. Categories of mineral soils can be identified by hand texturing. Take about a dessertspoon of soil. If dry, wet it gradually, kneading thoroughly between finger and thumb until aggregates are broken down. Enough moisture is needed to hold the soil together and for the soil to exhibit its maximum cohesion. There are two questions to be answered.

Question 1: Is it difficult to roll the moist soil into a ball?
Answer: YES, then the soil category is "Sand".
NO, then ask the second question.

Question 2: Does the moist soil feel smooth and silky as well as gritty?
Answer: NO, then the soil category is "Sandy loam".
YES, then the soil category is "Other mineral soil".

"Humose soils" and "Peaty soils" are identified by percent organic matter. They are characterised by a dark colour with a high organic matter content which can be confirmed by laboratory analysis.

Table 1. Soil category assessment

Soil type	Description of soils within category	Properties
Shallow soils	All mineral soils which are less than 40cm deep.	Soils are less able to retain or supply N at depth.
Sands	Soils which are sand and loamy sand textures to a depth of more than 40cm.	Soils have poor water-holding capacity and retain little N.
Sandy loams	Soils which are sandy loam texture to a depth of more than 40cm.	Soils have moderate ability to retain N and allow average rooting depth.
Other mineral soils	Soils with less than 15 percent organic matter that do not fall into the sandy or shallow soil category, i.e. silty and clay soils.	Soils can retain more N than lighter soils and allow rooting to greater depth.
Humose soils	Soils with between 15 and 35 percent organic matter. These soils are darker in colour, stain the fingers black or grey, and have a silky feel.	Soils can retain more N than mineral soils and have higher N mineralisation potential.
Peaty soils	Soils that contain more than 35 percent organic matter.	Soils have very high N mineralisation potential.

Stage A2b. Assessment of N residues taking account of the previous crop or previous grass/clover management

The amount of fertiliser N that should be applied to any fruit crop in its first year will depend on the previous crop or grass/clover management in the field in which the crop is to be grown. Details of how to allocate the correct "Previous crop/grass nitrogen residue group" to the field are given in Tables 2 and 3.

Where crops other than grass have been grown prior to the fruit crop, these have been allocated into one of five previous crop groups. These groups are numbered 1 to 5 in ascending order of residual N in the soil, following harvest of the previous crop (Table 2). Residual available N in the soil following harvest will vary depending on the crop type grown. Residues following cereals are generally lower than those following leafy crops, potatoes, and legumes. The management and performance of the previous crop can have a significant effect on the level of N residues. Residues are expected to be lower in a high-yielding season, or where N application has been less than normal, but may be higher than average if the crop has performed badly as a result of problems such as disease or drought. In the tables of N recommendations in this Note, it is assumed that all previous crops have been managed well and that previous N fertiliser use has been close to the recommended rate, taking into account of any use of organic materials.

Nitrogen fertiliser and manure use in the last 2 years of grassland management, and grazing management during the months immediately prior to ploughing out grassland will have a significant effect on the level of N residues. Management of the previous grass/clover sward have been allocated into one of five Groups. These Groups are numbered 2 to 6 in ascending order of residual available N in the soil following ploughing out of the grassland (Table 3). Groups 2 to 5 have the same N residues as Groups 2 to 5 in the Previous Crop Groups (Table 2), whereas Group 6 has a higher residue of available N.

Table 2. Previous crop groups in ascending order of residual available N in the soil following harvest

Group	Previous crop
1	spring barley, spring oats, spring rye, spring wheat, winter barley, winter oats, winter rye, winter wheat, whole crop, triticale, carrots, shopping swedes, turnips (human consumption), linseed, onions, asparagus, radish, narcissus, tulip, swedes/turnips (stock feed), parsnips, ryegrass (seeds)
2	forage maize, forage rape, green manure crop, kale cut, winter oilseed rape, spring oilseed rape, hemp, courgette, pumpkin, beetroot (red baby, other), vining peas, combining peas, potatoes (<60 days, seed and punnets), potatoes (60-90 days, seed and punnets), potatoes (60-90 days, ware), potatoes (90-120 days), potatoes (>120 days), blackberries, loganberries, blackcurrants, redcurrants, blueberries, tayberries, strawberries, raspberries, gooseberries
3	harvested fodder (root only), beans (broad), beans (dwarf/runner), beans (field vining), lupins, leeks, lettuce, rhubarb, uncropped
4	grazed fodder, turnips grazed, kale grazed, forage rape grazed, chicory pure stand grazed
5*	leafy brassica vegetables, leafy non-brassica vegetables, brussels sprouts, cabbage (all types), calabrese (broccoli), cauliflower
*N residues can be variable in this group. Analysis of the crop debris for total N and C content prior to ploughing down is recommended to help predict release of available N for the next crop.	

Table 3. Previous grass/clover groups in ascending order of residual available N in the soil following ploughing out

Group	Previous grass/clover management
2	1 – 2-year low N[1] leys and not grazed within 2 months of ploughing out or during Sept./Oct.
3	1 – 2-year low N leys and grazed within 2 months of ploughing out or during Sept./Oct. 1 – 2-year high N leys and not grazed within 2 months of ploughing out or during Sept./Oct. Thin, permanent grass, low N, no clover
4	1 – 2-year high N leys and grazed within 2 months of ploughing out or during Sept./Oct. 3 – 5-year low N leys and not grazed within 2 months of ploughing out or during Sept./Oct. Thick, permanent grass, low N
5	3 – 5-year high N leys and not grazed within 2 months of ploughing out or during Sept./Oct. 3 – 5-year low N leys and grazed within 2 months of ploughing out or during Sept./Oct. Permanent grass, high N, not grazed within 2 months of ploughing out or during Sept./Oct.
6	3 – 5-year high N leys and grazed within 2 months of ploughing out Permanent grass, high N, grazed within 2 months of ploughing out
[1]Low N means less than 150 kg/ha/year fertiliser N used on average in last 2 years. High N means more than 150 kg/ha/year fertiliser N used on average in last 2 years or high clover content.	

Some growers may wish to test their soils for soil mineral nitrogen (SMN). SMN testing can give useful additional information about soil N supply where it is likely to be high or uncertain; where regular inputs of organic manures are used; or where large amounts of leafy crop residues have regularly been incorporated e.g. Group 4 and 5. SMN measurement is not recommended in established grassland, or in the first year after ploughing out grassland.

Care must be taken when interpreting results of SMN testing, since SMN concentrations can vary widely from day to day depending primarily on soil temperature and rainfall. When measuring SMN before a fruit crop you do not need to add an estimate of N mineralisation during the growing season as this is already considered in the recommendation tables.

Guidance on how to collect a SMN sample can be found in Section 6 "Vegetables and bulbs", Nutrient Management Guide (RB209, 2020). The main considerations for vegetable and fruit crops when SMN sampling, which are distinct from other crops are:

- Take SMN samples as close to planting date as possible, but not within 2 months of applying N fertiliser or organic materials.
- Take samples in 30 cm sections to 90 cm or to rooting depth. Use Table 4 to identify the correct N residue group based on sampling depth.

Samples should be analysed for nitrate-N and ammonium-N. Analytical results in mg N/kg should be converted to kg/ha, considering the dry bulk density of the soil, then summed to give a value for the whole soil profile. For most mineral soils, a "standard" bulk density of 1.33 g/ml can be used, and the calculation can be simplified to:

SMN (kg N/ha) = mg N/kg x 4 (for each 30 cm layer of soil)

Table 4. SMN based on sampling (N kg/ha) to 60 and 90 cm depth and ascending order of Nitrogen Residue Groups

	Nitrogen Residue Group					
	1	2	3	4	5	6
	kg N/ha					
SMN kg/ha to 60 cm	<40	40-53	54-67	68-80	81-120	>120
SMN kg/ha to 90 cm	<60	60-80	81-100	101-120	121-180	>180

Stage A2c. Crop to be grown

Nitrogen fertiliser is not required before planting fruit crops except strawberries. The N recommendations for strawberries and rhubarb crops in the establishment year are listed in Table 5. The required N can be applied wholly as manufactured fertiliser, although some may be derived from organic materials and from soil reserves.

Table 5. Nitrogen recommendations[1] (kg/ha) for soft fruit and rhubarb crops in establishment year

Crop	Previous crop or grass/clover group[2]					
	1[2]	2	3	4	5	6
Strawberries (main season)	40	30	20	0	0	0
Strawberries (everbearers)	80	60	50	30	10	0
Rhubarb	160	150	140	120	80	40

[1]N application can be made at planting or split between planting (Spring) and early Summer.
[2]For full descriptions of previous crop groups and previous grass/clover groups, see Tables 2 and 3.

Stage A2d. Adjustments for soil category, crop variety and production practices

The standard N recommendations in Table 5 are for crops grown in sandy loams, other mineral soils, humose and peaty soils. For crops grown in sands and shallow soils, the N recommendation should be increased by 10%.

Adjustments to the N recommendations given in Table 5 may have to be made for different crop varieties to optimise early crop growth, crop quality and economic performance.

Where crops are grown under protection for all or part of the season (e.g. in Spanish tunnels), it may be possible to reduce the N application.

Leaf analysis can be used to determine whether crops are receiving sufficient N for optimal yields of quality fruit (see Section E). Specialist guidance may be needed when deciding on N fertiliser application rates in relation to any of the factors discussed above.

Stage A2e. Adjustments for Winter rainfall

The drier the Winter and the greater the soil capacity to hold water, the smaller the proportion of N from crop residues that will be washed out of the soil before crop growth starts in the Spring. If Winter rainfall between 1 October and 1 March is more than 450 mm, then the standard N recommendations should be adjusted according to Table 6.

Table 6. Adjustment to standard N recommendation following excessive Winter rainfall

Crop	Winter rainfall > 450 mm		
	Sands, sandy loams and shallow soils, previous crop group 2	Sands, sandy loams and shallow soils, previous crop groups 3 - 6	All other soils, previous crop groups 2 - 6
All fruit crops	Add 10 kg/ha	Add 20 kg/ha	Add 10 kg/ha

Stage A2g. Adjustments to N recommendations following applications of organic fertilisers

Many growers of fruit crops choose to apply organic fertilisers including animal manures, composts, anaerobic digestates and biosolids as part of their fertiliser strategy and to maintain or enhance soil quality. It is important that full account is taken of the fertiliser nutrients including N to optimise crop quality, economic performance and to minimise any environmental impact through leaching of excess N as nitrate. The amount of N available to the crop in the years following the application of organic materials depends on the type of material applied, the method of application, the soil category, and the month and year of application. Applications of organic materials to individual fields should not exceed 250 kg /ha of total N from the organic material in any 12-month period, which is mandatory in NVZs. Compost should not be applied to any field where the application would result in the total N contained in organic manure (including compost) applied to any field in any 24-month period exceeding a rate of 500 kg/ha, which is mandatory in NVZs. The area of the field used to calculate the 250 kg/ha limit should exclude any areas where manures are not spread. Information on the N contents of organic materials can be found in SRUC Technical Notes TN699 and TN736 (www.fas.scot/publications/technical-notes/).

A3. Phosphate (P_2O_5), potash (K_2O) and magnesium (Mg) recommendations for new crops

To assess the P, K and Mg fertiliser requirements during the establishment phase for each crop, the following factors need to be considered:

Stage A3a:	Target soil P and K levels	
Stage A3b:	Adjustments based on soil P sorption capacity (PSC)	Table 7
Stage A3c:	Crop to be grown	Table 8
Stage A3d:	Adjustments following applications of organic materials	

Stage A3a. Target soil P and K levels

Where soil analysis before planting shows low concentrations of soil P, K or Mg, it is important to apply appropriate amounts of P, K, Mg fertiliser based on the recommendations in this technical note on the assumption that upper moderate soil status (M+) results in high yield potential in soft fruit crops. Phosphate helps root development, early growth, and the ripening of seeds but over-use of P can lead to P loss from agricultural land to fresh waters and impair water quality. Care should be taken to avoid building up crop-available phosphate above the target P Status. Recent research has shown that phosphate transfer from soil to surface water increases as soil P Status increases. Much of this transfer is due to the loss of crop-available phosphate through land runoff.

Maintaining an adequate level of soil K over the long term is important because, on K deficient soils, it is difficult to distribute fresh K fertiliser sufficiently evenly throughout the rooting zone in the season it is applied, and for the roots to access it so that the crop can respond to all of the applied N fertiliser and produce optimal yields. Potash promotes root development and gives strength and stiffness to the whole plant.

Stage A3b. Adjustments based on soil P sorption capacity (PSC)

Attaining soil P at the target upper moderate soil status (M+) ***may require additional P to increase the reserves of P in the soil prior to planting***, depending on the soil P sorption capacity (PSC). The PSC of a soil refers to the differing capacity of

soils to bind with applied P making it temporality unavailable for plant uptake. Data from the Soil Survey of Scotland for each soil association have been used to create a map of ranking of PSC for non-calcareous soils from low (PSC 1) to high (PSC 3) (see SRUC Technical Notes TN715 to TN718 (www.fas.scot/publications/technical-notes/). Maintaining soils at target soil P levels is only justified if the land is being actively managed for high potential yields. This requires that other good soil management targets such as pH, nutrient planning as well as soil structure and adequate drainage status are also considered. Soils of PSC 3 will maintain the lowest P concentrations in soil pore water. This relationship explains the observation that despite equivalent soil P Status, high P sorption soils often require additional fertiliser to maintain target plant available P. However, those soils with high PSC that are maintained on target for P represent the greatest erosion risk to water quality as they will contain a higher level of adsorbed P from fertilising.

The effect of PSC index on kg P_2O_5/ha required to change the results of a soil P test is shown in Table 7. A slower build-up of soil P will be achieved when slightly more than the required P is applied annually as inorganic, soluble P over several years, compared with single, large applications of P in organic fertilisers (see Section B for established crops). The changes shown in Table 7 are 5 mg/l increments of extractable soil P from 2 to 7 mg/l i.e. from very low (VL) to lower moderate (M-); and 7 to 12 mg/l i.e. lower moderate (M-) to upper moderate (M+). The changes in P on an area basis (kg P_2O_5/ha) are calculated based on an estimated amount of soil in 1ha to 20cm depth as 2,400 t. The table shows that more than twice the amount of P is required to move from 2 to 7 mg/l P (i.e. from VL to M- P status) than to move from 7 to 12 mg/l P(i.e. from M- to M+ P Status); and about twice the amount of P is required in PSC 3 soils than PSC 1 soils to move to M- and M+ P Status. Growers are advised to build soil P status over a period of years rather than all at once. Very high applications of fertiliser P present a risk of 'incidental' P loss if heavy rainfall follows soon after application regardless of soil P status.

Table 7. The effect of PSC index on kg P_2O_5/ha required to change soil P test result.

PSC index	Change in P on an area basis from 2 to 7 mg/l (kg P_2O_5/ha)*	Change in P on an area basis from 7 to 12 mg/l (kg P_2O_5/ha)*
PSC 1	240	110
PSC 2	340	145
PSC 3	550	220

*using an estimated amount of soil in 1ha to 20cm depth as 2,400 t

Stage A3a. Crop to be grown

The recommendations provided in Table 8 will ensure sufficient supply of P, K and Mg to replace crop offtake of establishing crops. Where the soil is below the target status, the recommendations given in Table 8 are higher to allow the soil to 'build up' to the target status over time.

For phosphate fertilisers, use only those that contain a large proportion of water-soluble phosphate. Where more than 120 kg/ha of potash is required for redcurrants, gooseberries and raspberries, sulphate of potash (K_2SO_4) should be used rather than muriate of potash (KCl), since fruit crops are sensitive to excessive soil chlorine concentrations. To avoid inducing Mg deficiency, the soil K:Mg ratio (based on soil mg/l K and Mg) should be no greater than 3:1.

Table 8. Phosphate, potash, and magnesium recommendations (kg/ha) for soft fruit and rhubarb crops in establishment year

Crop	Soil P, K or Mg status			
	Low (L)	Lower moderate (M-)	Upper moderate (M+)	High (H)
Soft fruit				
Phosphate (P_2O_5)	100	75	50	25
Potash (K_2O)	100	75	50	25
Magnesium (MgO)	120	90	60	30
Rhubarb				
Phosphate (P_2O_5)	150	120	90	60
Potash (K_2O)	225	200	175	150
Magnesium (MgO)	80	60	40	20

Stage A3b. Adjustments to P, K and Mg recommendations following applications of organic materials

The amount of P, K and Mg available to the crop in the years following the application of organic materials depends on the type of material applied, the method of application, the soil category, the month of application and the number of years since application. Information on the P, K and Mg contents of organic materials can be found in SRUC Technical Notes TN699 and TN736 (www.fas.scot/publications/technical-notes/).

B. Nutrient recommendations for soil-grown established crops

B1. Nitrogen recommendations for established crops

To assess the N fertiliser requirements for established fruit crops and rhubarb, the following factors need to be considered:

Stage B1a:	Take account of soil category N assessment (see Table 1)	Table 9
Stage B1b:	Adjustments for variety/market	
Stage B1c	Adjustments for Winter rainfall	Table 6

Stage B1a. Crop being grown, taking account of soil category N assessment

The N recommendations for soil-grown, established fruit and rhubarb crops are listed in Table 9. Shallow soils and sands are less able to retain or supply N at depth. Sandy loams and other mineral soils retain more N than lighter soils and allow rooting to greater depth. Humose and peaty soils retain more N than mineral soils and have higher N mineralisation potential.

Soil nitrogen supply indices (or SNS indices) can also be used to give an indication of the amount of N which is likely to be available from soil reserves during cropping years. The SNS system is described in detail in the Nutrient Management Guide (RB209), updated February 2020. The SNS index can usefully provide evidence to show the instances where N applications can be reduced from the recommendations provided in Table 9, though reference to the RB209 must be made in order to ensure that the correct method is followed and that interpretation of the results is appropriate.

The required N can be applied wholly as manufactured fertiliser, although some may be derived from organic materials.

Table 9. Nitrogen recommendations (kg/ha) for established soft fruit and rhubarb crops

Crop	Soil type		
	Shallow soils and sands	Sandy loams and other mineral soils	Humose and peaty soils
Strawberries (main season)	60	40	20
Strawberries (everbearers)	80	60	40
Rhubarb[1]	180	160	120
Blackcurrants[2]	160	140	80
Raspberries, redcurrants, gooseberries, loganberries, tayberries, blackberries	120	100	60
Blueberries	60	40	20

[1]N recommendations are believed to be for crops harvested only once in a season.
[2]Apply N 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 N fertiliser recommendation should then be adjusted by following stages B1b and B1c.

Stage B1b. Adjustments for variety/market

Adjustments to the N recommendations given in Table 9 may have to be made for different crop varieties to optimise early growth, crop quality and/or yield. Leaf analysis should be used to determine whether crops are receiving sufficient N for optimal yields of quality fruit (see Section E).

Strawberries – With continued change in varieties, adjust N rates depending on plant vigour and the results of leaf analysis.

Rhubarb - The N recommendations are for crops harvested only once in a season. To achieve an extended season supply to meet retailer's demands, three crops from the same crowns within a single season are possible. As rhubarb is a perennial crop, these multiple harvests can occur year-on-year from the same crowns, placing increased demand on the plants. In addition, newer perpetual varieties have been developed which do not have a period of dormancy, and these may not have the inherent vigour of the older varieties.

AHDB have commissioned research on the nutrient requirements of these perpetual varieties; results from this research can be used to review rhubarb fertiliser recommendations in the future (SF 172: Developing Nutrient Management Recommendations for Rhubarb, 2019-2023

Blackcurrants - Varieties developed by James Hutton Ltd in the "Ben" series typically require 70-120 kg N/ha. Higher N rates may reduce fruit quality for processing.

Raspberries – The N recommendations for raspberries in RB209 (2020) are for both floricane and primocane varieties. For floricane varieties, N should be applied between the onset of floricane growth and the end of July. Avoid applying N after the end of July to avoid excessive growth of soft cane, unless N is applied at lower rates through fertigation, where N applications may continue until the end of August. For primocane varieties, N should be applied between emergence and early October. Avoid applying N 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 N are usually adequate. The rate should be adjusted according to the amount of growth required and the results of leaf N analysis.

Stage B1c. Adjustments for Winter rainfall

If Winter rainfall between 1 October and 1 March is more than 450 mm, then the standard N recommendations should be adjusted according to Table 6.

B2. Phosphate (P_2O_5) and potash (K_2O) and magnesium (Mg) recommendations for established crops

Further soil analysis is recommended every 3-5 years in established crops. For established crops, sample to 15 cm depth as a depth gradient in acidity and nutrient content will probably have developed. Soil P levels may decline in some soils due to gradual sorption, when only maintenance applications are made. Crops should be top-dressed according to the recommendations in Table 10 to build-up or run-down soil P, K, and Mg slowly over several years to target upper moderate soil status (M+). For phosphate fertilisers, use only those that contain a large proportion of water-soluble P. Effects of PSC on annual P adjustments to build-up or run-down soil P slowly over several years to target upper moderate P soil status (M+) are shown in Table 10.

Where more than 120 kg/ha of potash is required for redcurrants, gooseberries and raspberries, sulphate of potash (K_2SO_4) should be used rather than muriate of potash (KCl), since fruit crops are sensitive to excessive soil chlorine concentrations. To avoid inducing Mg deficiency, the soil K:Mg ratio (based on soil mg/l K and Mg) should be no greater than 3:1.

Table 10. Phosphate, potash, and magnesium recommendations (kg/ha) for established soft fruit and rhubarb crops

Crop	Soil P, K or Mg status (SAC)			
	Low	Lower Moderate (M-)	Upper Moderate (M+)	High
Strawberries				
Phosphate (P_2O_5)	70	50	40	20
Potash (K_2O)	150	80	80	40
Rhubarb				
Phosphate (P_2O_5)	150	125	100	75
Potash (K_2O)	225	200	200	150
Blackcurrants, redcurrants, gooseberries, raspberries, loganberries, tayberries				
Phosphate (P_2O_5)	70	50	40	20
Potash (K_2O)	180	120	120	60
Blackberries				
Phosphate (P_2O_5)	70	50	40	20
Potash (K_2O)	150	80	80	0
Blueberries				
Phosphate (P_2O_5)	30	20	10	0
Potash (K_2O)	30	20	20	0
All crops				
Mg (MgO)	65	50	50	25
Adjustment based on PSC index:				
PSC 1	0	0	0	0
PSC 2	+15	+5	0	-10
PSC 3	+30	+15	0	-25

C. Fertigation

Where strawberries or raspberries are grown under a polythene mulch with sub-irrigation, nutrients can be applied through an irrigation system (fertigation). On soils which encourage vigorous leafy growth, it may be beneficial to reduce N rates where fertilisers are applied through fertigation. Where growth is not excessive, N 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 status of upper moderate (M+) or above, maintenance rates of phosphate and potash can be applied through fertigation. However, where soil analysis shows lower moderate (M-) P or K soil status or below, the recommended amounts of phosphate and/or potash should be cultivated into the planting bed before the soil is mulched and make allowance for nutrients applied in organic materials. Irrigation water may also contain nutrients, particularly calcium (Ca) in hard water areas, and care should be taken when mixing with fertiliser, as insoluble compounds may form, which can block emitters.

D. Substrate strawberry production

It is often more practical or cost-effective to grow strawberries in an inert substrate in containers, rather than in soil. In this case, a complete nutrient solution is required. Normally a conductivity of at least 1.4 mS/cm is maintained during growth and production for main crop "June bearers" and the conductivity should not exceed 2.0 mS/cm. High salinity can cause marginal necrosis and may stimulate leaf and flower tip burn. During vegetative growth, the K:Ca ratio in the substrate (based on mg/l K and Ca) should be maintained at 0.65 and at 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 manganese and iron can occur when the pH values in the substrate are high (alkaline).

The nutrients applied will need to be adjusted depending on the substrate used. Peat or coir are the usual substrates for strawberry production. Coir is usually supplied dried and unfertilised. It should be thoroughly wetted for 2-3 days prior to planting with a nutrient solution. It needs more Ca, Mg, and sulphur (S), but less boron (B) and K when used fresh. Since it has an inherently high pH, coir needs a lower solution pH (5.3 – 5.8) than peat (which requires 5.6 – 6.0). Nutrient solution 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 solution analysis. Guidelines for nutrient solution for strawberry production on substrate are shown in Table 11.

Table 11. Guidelines for nutrient solution for strawberry production on substrate

Nutrient element	mg/l in dilute feed	Nutrient element	mg/l in dilute feed
Nitrogen (NO_3)	110 - 140	Iron (Fe)	1.1 - 1.7
Nitrogen (NH_4)	7 - 14	Zinc (Zn)	0.46 - 0.65
Phosphorus (P)	46	Boron (B)	0.11 - 0.17
Potassium (K)	140 - 250	Manganese (Mn)	0.55 - 1.11
Magnesium (Mg)	30 - 40	Copper (Cu)	0.03
Calcium (Ca)	140 - 180	Molybdenum (Mo)	0.05
Sulphate (SO_4)	50 - 100		

Values obtained from AHDB Factsheet on strawberry nutrition in soilless substrates
https://projectblue.blob.core.windows.net/media/Default/Imported%20Publication%20Docs/n06y07.pdf

E. Leaf analysis in growing crops

Leaf analysis is an important tool, which can be used in fruit crops to monitor crop nutrient status and to diagnose nutritional disorders. Separate samples should be taken from the same parts of good and poor plants, so that the results can be compared.

An understanding of leaf nutrient concentrations has proved useful in assessing the nutritional status of crops. Values obtained from RB209 (2020) are shown in Tables 10 and 11. Where analysis results are to be compared to these standards, it is essential that a representative sample is taken in the correct way, and at the correct time. Since there are seasonal and other factors that affect leaf nutrient concentrations, leaf analysis must be interpreted with care. Leaf nutrient concentrations can vary between varieties. Where there is sufficient information, the standard ranges take account of differences between varieties.

Where the leaf nutrient concentration is consistently above the standard range for several years, there is justification for a reduction in fertiliser use.

Table 12. Leaf analysis – nutrient ranges of major and secondary nutrients expressed as elements (% in dry matter)

Crop	Leaf sampling position[1]	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Sulphur (S)
Strawberries	1	2.6 – 3.0	0.25 – 0.30	1.5 – 2.0	0.15 – 0.20	0.10 – 0.20
Blackcurrants	2	2.8 – 3.0	0.25 – 0.35	1.5 – 2.0	0.15 – 0.25	
Raspberries	3	2.4 – 2.8	0.20 – 0.25	1.5 – 2.0	0.30 – 0.35	
Blueberries	4	1.8 – 2.1	0.08 – 0.40	0.4 – 0.7	0.12 – 0.25	0.12 – 0.20

[1]Leaf sampling position: 1 – lamina of recently matured leaves, sampled at fruit ripening; 2 - fully expanded leaves, extension growth, sampled prior to harvest; 3 - fully expanded leaves, non-fruiting canes, sampled at fruit ripening; 4 - fully expanded leaves between late July and mid August.

Table 13. Leaf analysis – nutrient ranges of micronutrients (m/kg in dry matter)

Micronutrients	Deficiency	Optimum	High
Manganese (Mn)	20	30 – 100	100[1]
Boron (B)[2]	15	20 – 40	40[3]
Zinc (Zn)	10	15 – 30	50
Copper (Cu)	5	7 – 15	15
Iron (Fe)	<45	45 - 250	

[1] Mn concentrations >100 mg Mn/kg indicate that the soil is becoming acid: check soil pH
[2] Fruit analysis is the most reliable diagnostic technique for B deficiency. Optimum concentrations are 1.5 to 4.5 mg B/kg fresh weight. Below 1.5 mg B/kg indicates deficiency.
[3] Excess B concentrations can promote premature ripening and senescence in fruit.

Authors

Audrey Litterick, Earthcare Technical Scotland, Dalnashian, Keltneyburn, Aberfeldy, PH15 2LQ, tel. 07785 796670.
Alex Sinclair, SAC Consulting, Ferguson Building, Craibstone Estate, Aberdeen, AB21 9YA, tel. 07776486966.
Lizzie Sagoo, ADAS, Boxworth, Cambridge, CB23 4NN, tel. 07833 520475.

Production of this SRUC Technical Note was funded by the Scottish Government as part of its Farm Advisory Service.