Garddwriaeth Cymru
Horticulture Wales

Knowledge exchange, collaboration and supply chain development.

Growing for quality

Growing quality crops benefits everyone in the supply chain. Growers get better prices, losses in storage and grade outs are reduced, wholesalers and retailers can build good reputations and secure customer 'loyalty', and the consumer gets a quality product.

This Guide covers soil fertility, crop varieties, pest and disease control and water management. Taken together, these factors promote vigorous plants that grow quickly to out-compete weeds, resist or tolerate pest and disease challenges, reduce problems during storage and minimise grade outs.

Soil fertility and management

Healthy soil is the foundation of a productive, sustainable production system. Soil management is a vast topic and the (in full) AHDB's Soil Management for Horticulture provides detailed information and practical guidance. These are the main points:

Nutrient requirements and supply

- Crops differ in their nutrient requirements. The table below shows the 'take offs' of the major plant nutrients - Nitrogen (N), Phosphorous (P) and Potassium (K) for some key crops.

Crop	Yields (t/ha)	Dry Matter (%)	Take off (Kg/Ha) (Calculated from % fresh weight)		
			Nitrogen (N)	Phosphorous (P)	Potassium (K)
Potatoes*	56	21	235	31	336
Beetroot	60	15	168	30	240
Onions	60	14	108	21	120
Carrots	20	16	60	8	120
Cauliflowers	35	7	98	15.75	105
Cucumbers	70	4	105	21	140
Lettuce	35	6	66.5	10.5	129.5
Cabbage	60	8	120	19.2	156
Tomatoes	250	4	438	67.5	610
Runner beans	25	8	62.5	10.0	62.5

Adapted from 'Nutrient off-take and nutrients in harvest residues of field vegetables' Institute of Vegetable and Ornamental Crops (IGZ) Leibniz (2013) except

** T. Westennann, 'Nutritional Requirements of Potatoes' Amer J of Potato Res (2005) 82:301-307*

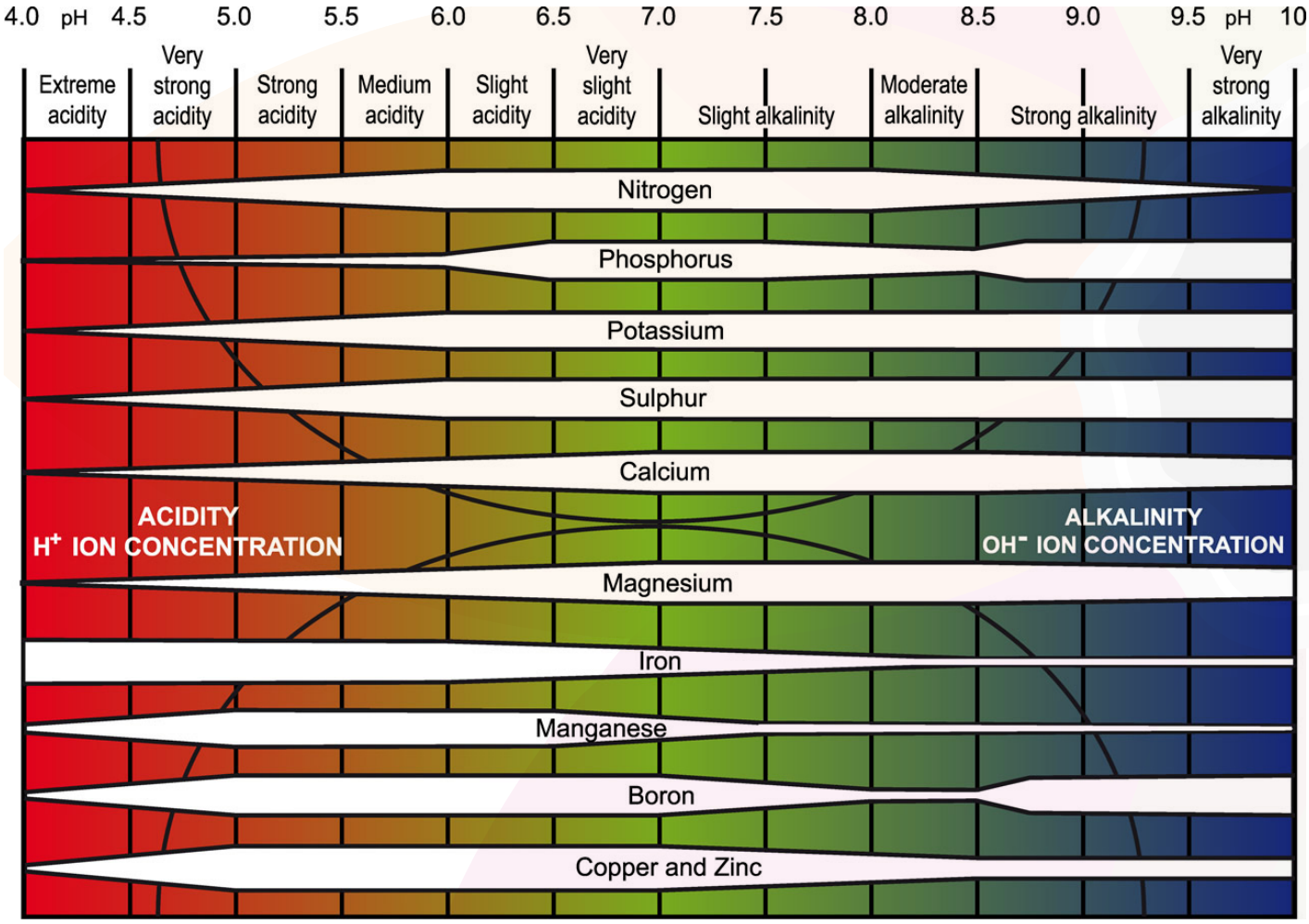
Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig
Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development:
Europe Investing in Rural Areas
Llywodraeth Cymru
Welsh Government
Prifysgol Glyndŵr Wrecsam
Wrexham Glyndŵr University

The balance of nutrients varies from crop to crop. Tomatoes, cucumbers and other crops where the fruit is harvested have a high demand for potassium; Brassicas and other leafy crops have a particularly high demand for Nitrogen; and potatoes have higher requirements for Phosphorous and Potassium.

- Other minor nutrients are needed (in some cases minute quantities) but are no less important for that. Calcium is vital in cell wall development and Boron because it helps prevent the collapse of the cell's plasma membrane. In practice, correct levels of these nutrients mean crops store better for longer. Sufficient Calcium, in particular, reduces blossom end rot in tomato and cucurbits. It helps prevent botrytis rots on brassicas in storage which is a major cause of post-harvest losses in these crops. AHDB's guide to the Principles of nutrient management and fertiliser use has more details.
- The Nutrient Management Guide published by AHDB will help you tailor nutrient supplies to individual crops and guidance on soil assessment and analysis methods can be found here.
- This factsheet is a useful summary for organic / agroecological growers on managing nutrients in these systems, focusing on the use of fertility building leys, green manures, compost and animal manures.

Nutrient requirements and supply

Although fertility is often discussed in the context of available nutrients in the soil, it is the extent to which those nutrients are actually taken up by the plant that really counts. Soil pH is a key factor in this. Nutrients are taken up at different rates at different pH levels, as summarised in the diagram below.



From: Soil analysis: key to nutrient management planning (2011), Potash Development Association

- There is no single pH that is ideal for all nutrients, but for vegetable growers a pH of 6.0 - 7.0 represents a happy medium.
- In Wales, the majority of soils tend towards being acidic. Soil amendments therefore tend to be through application of lime to increase the pH, at rates calculated from soil analysis results.

Soil biology and organic matter

Organic matter is a vital component of soil. It has many roles including:

- Holding soil aggregates together and maintaining the structure;
- Feeding soil microbes that make the nutrients locked up in organic matter available to the plants
- Food for many other (non-microbial) types of soil organism
- Enabling soils to capture and store carbon (More here)
- Retaining soil moisture (further guidance later in this series).

Organic and agroecological growers are particularly focused on building soil organic matter (SOM) which can be achieved through: Crop rotations incorporating fertility building phases; short term green manures; and use of composts and animal manures. This guide sets out the basics. However, increasing SOM is essential to all growers, regardless of size or system. This case study shows how incorporating green manures into a field scale conventional brassica system brought real benefits.

Soil structure

Soil structure is central to a productive functional soil. A good open structure with plenty of air spaces which allows oxygen in (for respiration of soil organisms), helps good drainage and ensures efficient supply of nutrients and water to the plant. Several factors determine soil structure

- Texture – the relative proportions of clay, sand and silt. This is largely dictated by the underlying geology. It is very important, but there is usually little growers can do to change it
- Soil Organic Matter. As discussed above, SOM is vital in building and maintaining structure.
- Structural damage. Soil structure can seriously damaged by:
    - Cultivating wet soil, particularly on heavier soils. It could take years to remedy soil structure after inappropriate cultivation and be very costly in terms of reduced yield, quality and drainage.
    - Compaction by stock and/ or machinery. Minimise compaction from machinery by avoid driving on wet fields (wet soil is extremely vulnerable to compaction damage); reducing machine size and total axle loads; and reducing tyre pressures (see Soil Management for Horticulture for details).

Variety selection

Choice of variety is a balance of a number of factors including growing conditions, soil type, supply chains and markets. Historically, the National Institute of Agricultural Botany (NIAB) conducted extensive trials looking at a wide range of factors such as yield, pest and disease resistance, vigour and other agronomic characteristics. However, over the last 15 years, seed companies have become the primary source of this type of information. The exception is potatoes and AHDB Potatoes still maintains a database of varieties here

The route to market has a huge influence on choice of variety.

- Producing for a large wholesaler or a supermarket supply chain usually requires growing large volumes of a small range of crops, harvested in one or two passes. The whole crop therefore needs to come ready for harvest at approximately the same time. Most growers producing for this market therefore favour F1 hybrid varieties which are reliably uniform.
- Growing for a box scheme or a market stall means harvesting smaller volumes of a wide range of crops over a long period. Here plants need to ripen at different times over a period of weeks or even months, and open pollinated varieties tend to be more appropriate.

- The period/ season over which produce is required is a key factor. Many crops have early/ late/ spring/ autumn/ winter varieties. It is possible to achieve all-year-round (AYR) supplies of some crops such as cauliflowers in the field, and over wintering leafy salad crops in polytunnels. Five or six different varieties may be needed to achieve AYR production.
- The degree of mechanisation and the number of handling steps post-harvest needs to be considered. For example, where machines are used to pack and grade tomatoes, varieties with thicker skins are required. These withstand mechanical handling (and this is one of the reasons many people think thinner-skinned, home-grown tomatoes taste better).
- If crops are to be stored, some varieties may keep better than others: Some varieties of onions are bred specifically with storage in mind; some varieties of carrot are more frost tolerant than others and therefore store better in the field; and some potatoes such as Sarpo varieties have strong dormancy bred into them so they can be stored well into spring without the need for cold storage.

Pest, disease and weed management

From a post-harvest perspective, managing pests and diseases in the growing crop is important for two reasons

1. **To reduce the number of out-grades**
2. **To minimise infestations/ infections that subsequently develop in storage and cause significant losses.**

Successful P & D management increases the market fraction – the proportion of the crops grown that are saleable. Integrated Pest/ Disease management systems are now well developed for many pest/ pathogen/ crop systems. These systems view the application of pesticides as a last resort, and first and foremost they rely on a combination of non-chemical methods (Organic producers rely almost entirely in these approaches). They include:

- Cultural control. This is about how the crop is grown and includes crop rotations, planting and harvesting times, cultivation practices to manage soil pests and weeds, and variety choice;
- Physical/ mechanical methods. These include weeding, using non-woven fleece, mesh or nets to prevent insects/ birds getting at the crop, mulches to manage weeds etc;
- Biological control. Either by actively introducing beneficial predators/ parasites (most applicable to glasshouses/ poly tunnels), or by enhancing the environment/ creating habitat for beneficial on the farm and within the cropping system;
- Bio-pesticides. These are ‘natural’ pesticides. They can be based on plant extracts (e.g. garlic), microbial toxins (such as Bacillus thuringinenses), or from living pathogens such as entomopathogenic fungi that feed on insects such Beauveria and Metarhizium.

For further information see Guide No 3 in this series: Pest, Weed and Disease Management’

Water management

Avoiding water stress, whether due to too much or too little, is key to growing heathy and vigorous crops. Often, the effects of water stress are quite general, for instance delayed crop development, reduced yields, or reduced ability to resist/ tolerate pests and diseases and outcompete weeds. However, in some crops there are specific consequences post-harvest. For example, dry conditions at tuber initiation promote scab in potatoes and erratic watering can lead to splitting in tomatoes. For further information see Guide No 2 in this series: ‘Water Management’

Summary

Although this series of guides focuses on post-harvest issues, good crop husbandry and management in the field has a profound effect on the efficiency of the supply chain. It is largely about getting the basics right; good soil and nutrient management, supplying and maintaining optimum soil moisture levels, appropriate variety selection, and keeping on top of pests, weeds and diseases.

Resources

Guides and factsheets

- ***Soil Management for Horticulture AHDB Horticulture***
  https://horticulture.ahdb.org.uk/publication/soil-management-horticulture
- ***Nutrient Management Guide (Sections 1 and 6) AHDB***
  https://ahdb.org.uk/RB209
- ***Phosphorus and potassium in organic systems: Getting the best from your soils Organic Centre Wales***
  http://organiccentrewales.org.uk/uploads/l1_pandkbestfromsoiljune2010engx.pdf
- ***The importance of soil organic matters: Key to drought resistant soil and sustained food production. FAO*** http://www.fao.org/3/a-a0100e.pdf
- ***A farmer's guide to organic fruit and vegetable production Organic Centre Wales***
  http://www.organiccentrewales.org.uk/uploads/hortguide_eng.pdf
- ***Using green manures to optimise nitrogen availability to Brassica crops Innovative Farmers***
  https://www.innovativefarmers.org/field-lab/?id=e94c6449-cb51-e711-8140-005056ad0bd4
- ***Potato Variety Database AHDB Potatoes***
  https://potatoes.ahdb.org.uk/online-toolbox/potato-variety-database

Research papers

- ***AHDB Calcium Review:***
  https://horticulture.ahdb.org.uk/sites/default/files/research_papers/FV%20457%20ADAS%20Review.pdf
  ADAS
- ***Reducing wastage in stored winter cabbage and swede AHDB Horticulture***
  https://horticulture.ahdb.org.uk/sites/default/files/research_papers/FV%20430_Report_Final_2016_0.pdf
  AHDB
- ***Independent assessment of field and storage potential of onion varieties 2017/18, AHDB Horticulture***
  https://horticulture.ahdb.org.uk/publication/independent-assessment-field-and-storage-potential-onion-varieties-201718
- ***Field storage of carrots: Identifying novel techniques AHDB Horticulture***
  https://horticulture.ahdb.org.uk/project/carrots-identifying-novel-field-storage-techniques
- ***Characteristics of Sarpo potato varieties Sarpo Potatoes Ltd***
  http://sarpo.co.uk