BASF Agricultural Solutions

Pea Growth Guide

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Welcome

Welcome to the ultimate guide to growing peas! As the demand for plant-based protein increases, the pea market has been steadily growing. Not only are they a profitable crop, but they also provide numerous benefits to other crops and offer an opportunity for grass weed control.

In this comprehensive guide, we will cover everything you need to know to successfully grow peas, from establishment to harvest. We will start by discussing the ideal conditions for growing peas and the best practices for seed selection and drilling.

We will then move to cover the various management techniques required throughout the growing season, including pest and disease control and weed management.

Finally, we will delve into the best harvesting practices and provide tips for post-harvest handling and storage. Whether you are a seasoned agronomist or new grower, this guide is designed to provide you with the knowledge and tools you need to successfully grow peas.

Contents

Why include peas in the rotation?

Peas are competitive and profitable against other arable crops on the farm and have a very positive effect on the whole farm rotation. This is due to pulses (both peas and beans) providing a significant yield boost to a following first wheat crop, thanks to the various positive impacts they have on soil fertility.

This includes the deposition of biologically fixed nitrogen and the improvement of soil texture and microbial balance. The flowers of pulses are also attractive to pollinators.

Spring combining peas in particular are very versatile, providing high yields and good returns. Their tolerance to drought stress allows good yields in low rainfall areas, as well as them maturing early enough to allow production as far north as central Scotland.

Pulse crops also provide disease breaks for cereals and oilseeds and have the advantage of spreading the workload on farms, thus helping to extend and diversify the crop rotation.

Markets

Peas are grown in Europe for the fresh vegetable/frozen (vining) and the dried pulse crop (combining) markets. Combining peas are mostly used for human consumption or as a high protein component of pet and livestock feeds. White flowered varieties are the main focus with all of them being suitable for premium markets, but some can also be used for animal feed.

More specifically, yellow peas are primarily used for animal feeds, with small quantities being used for canning as ‘pease pudding’ and as split peas in ingredients for soups and prepared meals. Green peas are used in the animal compounding market, with larger seeded varieties available to be sold for micronizing and for human consumption for export or UK packet sales.

Small seeded varieties are used on a limited scale for canning as small processed peas, for micronizing or for the pigeon trade. Marrowfat pea varieties are the most important for human consumption, being used for both dry packet sale and canning as large processed peas. Coloured flowered (maple) varieties are principally used in the pigeon trade, with a small specialist export market existing for human consumption.

In terms of vining peas, varieties are mainly produced for freezing with those with the highest resistance to downy mildew and powdery mildew being favourable.

Yield determination and potential

Yield determination

Crops can be regarded as "Energy Harvesters" – plants convert natural resources (solar energy, carbon dioxide and water) into edible energy. Water is required in proportion to energy captured, so crop yields are best understood as resulting from:

- Available **resources**
- Their **capture**
- Their **conversion** to harvestable grain or seed.

Yield is calculated differently depending on if the crop was grown in a light or water limiting year:

If light is limiting:

Yield (t/ha) = Light energy (TJ/ha) x Capture (%) x Conversion (t/TJ) x Harvest Index

If water is limiting:

Yield (t/ha) = Available Water* (mm) x Capture (%) x Conversion (t/ha/100mm) x Harvest Index

*the sum of spring and summer rainfall and soil-held water.

Light capture

Depends on the size of the green canopy and its longevity.

Water capture

Depends mainly on rooting depth, which is typically 0.7m for field peas, but could exceed 1.0m if soil depth and conditions allow.

Harvest Index

The proportion of total crop biomass which is harvested as grain. Average harvest indices have been measured at 0.52 for field peas.

Resource conversion

Rates of energy capture, carbon dioxide fixation and water transpiration by crop canopies are inherently linked (Figure 1 on next page), so light use, water use and biomass formation are roughly proportional.

Benchmark rates of conversion by pea canopies are 1 tonne biomass per terajoule (TJ) of light energy intercepted, and about 4 t/ha biomass per 100mm of water captured and transpired.

Nitrogen fixing crops must use some of the energy captured to fix nitrogen, hence their conversion efficiencies are less than non-nitrogen fixing crops.

Resource conversion can be reduced if storage capacity for assimilate is insufficient, e.g. low number of seeds set (sink limitation).

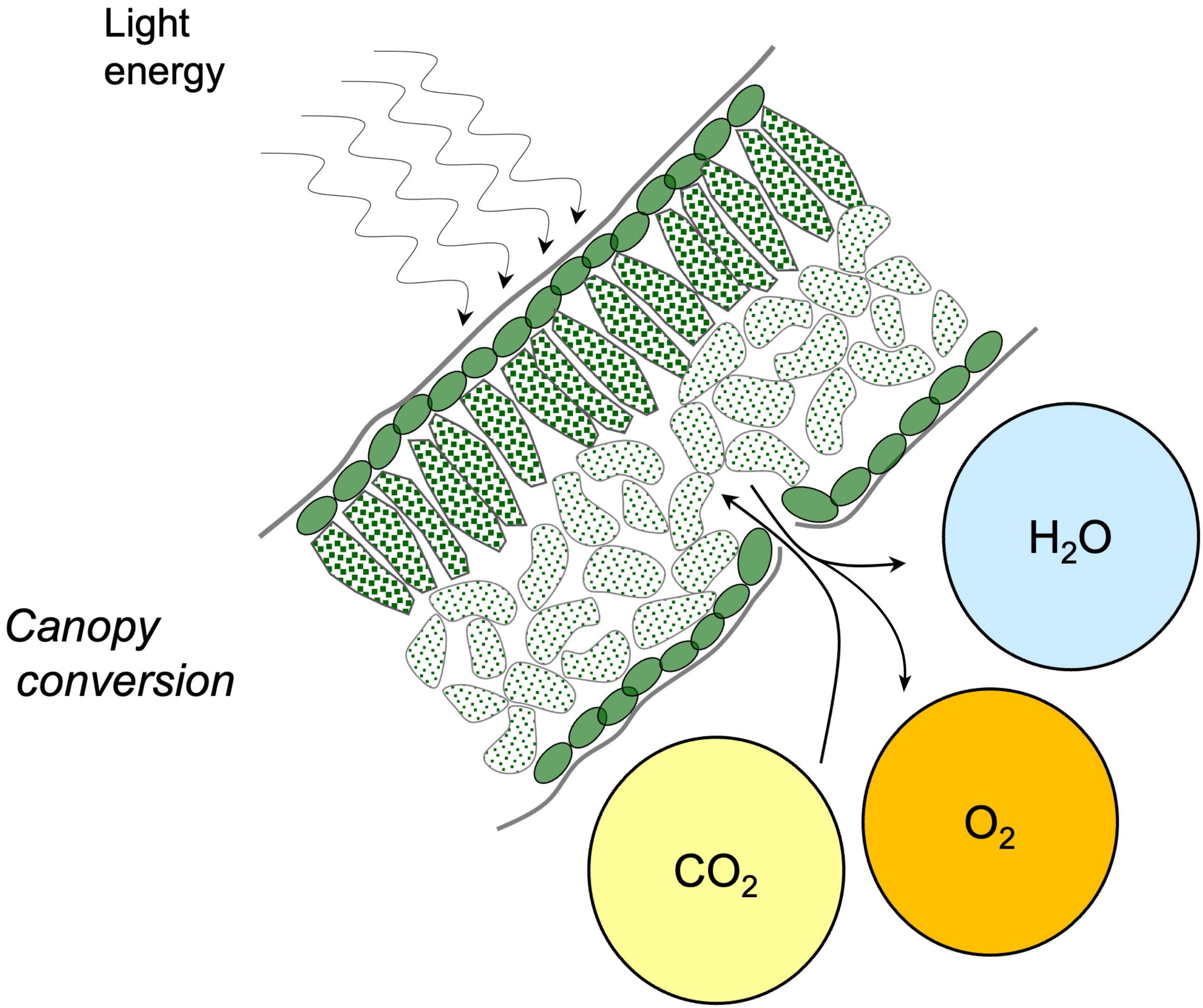


Figure 1.
Canopy capture and conversion of natural resource

Yield potential

Enhancing grain yields

Taking average sun and rainfall available in the UK, with season-long solar energy capture as 50% for field peas, its conversion to 1 t/TJ, and a harvest index of 60%, potential grain yields for peas would be about 7 to 8 t/ha on light soil types (160mm available soil water; Figure 2a on next page) and about 9 to 10 t/ha on water retentive soil (260mm available soil water; Figure 2b on next page).

This is far more than average yields that are currently achieved. New varieties and improved agronomy practices must be developed and combined synergistically, to achieve such yield potentials.

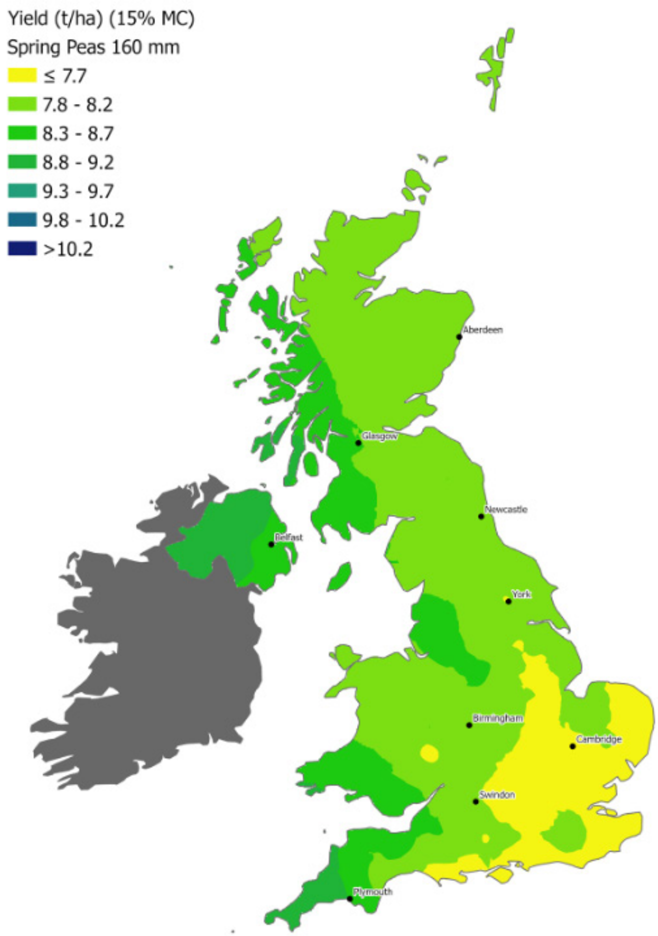
Energy capture can be increased mainly by delaying canopy senescence. Such canopies will often need to capture extra soil water, which will require deeper roots.

Mapping yield potentials

Southern regions receive most solar radiation and western regions receive most rainfall, so greatest yield potentials are in the South-West whilst lowest potentials are in the North and East. Local soil variation will affect the yield potentials calculated in Figure 2a and 2b.

a)

b)



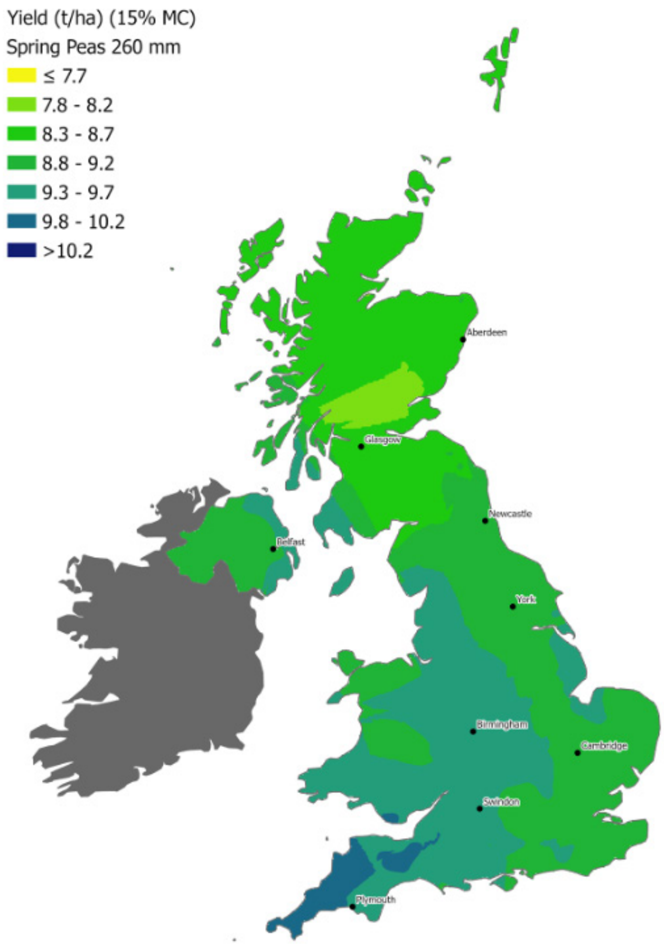


Figure 2.
Long term average potential yields of field peas from 2012-2022 in a) 160 and b) 260 mm available soil water environments

Nitrogen fixation

Enhancing grain yields

Nitrogen (N) fixation is one of the biggest benefits of growing pulses in rotations. The amount of nitrogen fixed by pulses typically ranges between 150 to 240 kg N/ha but can be as high as 340 kg N/ha. There are many factors which can influence this, some of which can be influenced by management.

Soil mineral nitrogen

Although pulses are known for relying on their symbiosis with Rhizobium to fix nitrogen, they can also utilise soil mineral nitrogen (SMN). Typically, 50-60% of the total nitrogen uptake by pulses is from fixed nitrogen but can reach as high as 70-80% in forage legumes. However, high concentrations of SMN (200-250 kg N/ha) will inhibit nitrogen fixation, which can reduce total nitrogen uptake from fixed nitrogen to 35-50%.

pH

pH 6.5 is the optimal pH for nitrogen fixation to occur. Avoid soils becoming lower than pH 5.5.

Temperature

Nitrogen fixation is most effective when soil temperatures are between 7°C and 20°C. Nitrogen fixing nodules develop around 3-5 weeks after plant emergence.

Phosphorus and Molybdenum

Deficiencies in mineral nutrition can reduce nitrogen fixation, especially phosphorus (P) and molybdenum (Mo).

Sunlight

Nitrogen fixation requires lots of energy, using about 30% of the energy captured by the plant through photosynthesis (Figure 3 on next page). It is essential that plants continue to fix nitrogen through the flowering period to supply enough nitrogen for seed growth. This means that it is important to maintain a green and healthy canopy for as long as possible to provide enough energy via photosynthesis for grain filling.

Other factors

Other factors which limit either root growth and exploration of the soil or nodulation will also limit nitrogen fixation. For example, poor soil structure (i.e. compaction, dry soils, waterlogging) and salinity.

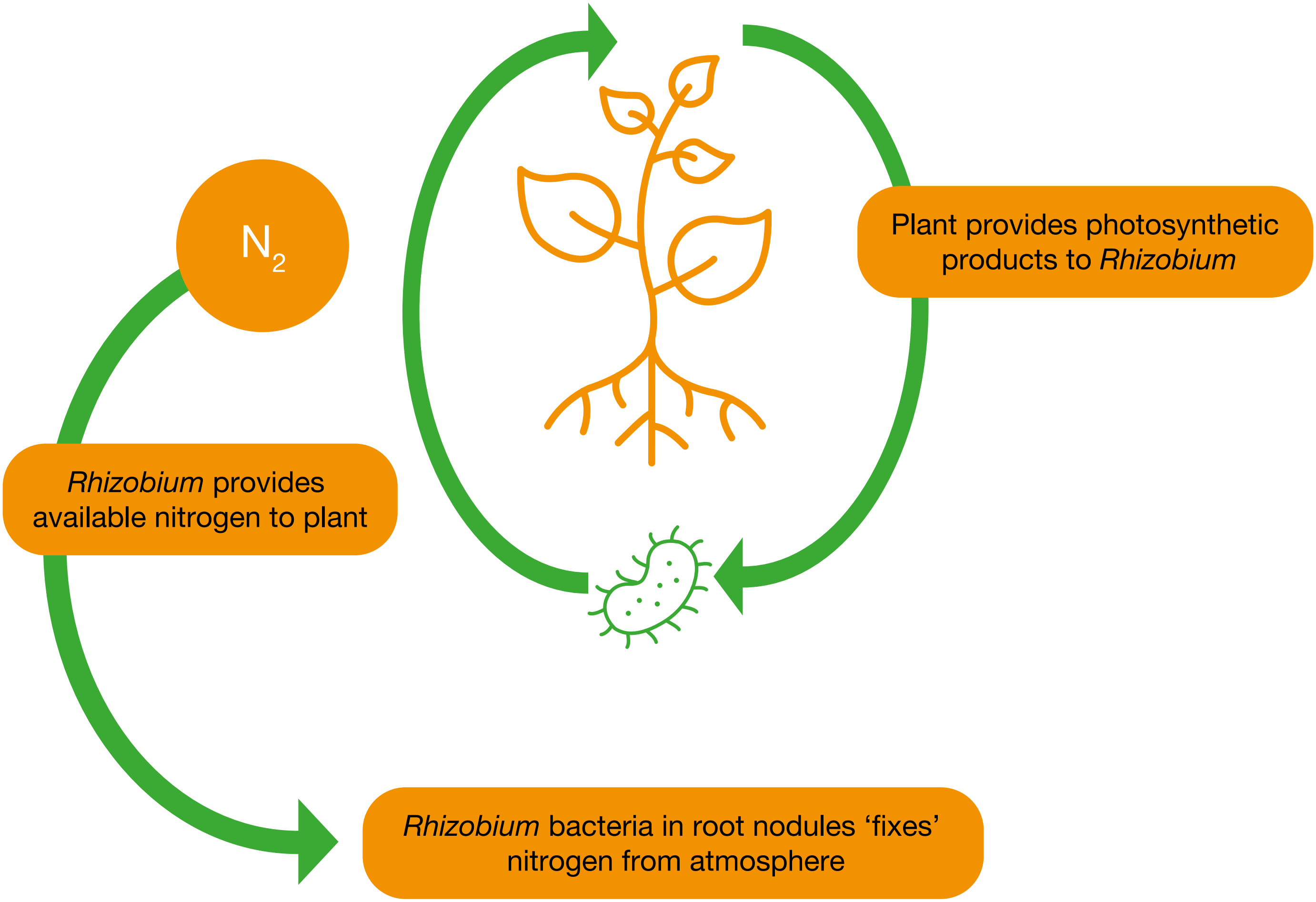


Figure 3.
Nitrogen fixation cycle

Canopy expansion and light interception

3 types of leaf morphology

1. **Conventional:**
   Stipules (pair of leaves next to main stem) and leaflets.
2. **Semi-leafless (most common):**
   Leaflets replaced with tendrils. Stipules remain.
3. **Leafless**
   No leaflets or stipules.

Canopy size can be expressed as Green Area Index (GAI) – the ratio of total green area to the ground area occupied.

A GAI of 5 units should be sufficient for a crop to intercept 90% of incident light (Figure 4). Aim to reach this canopy size by mid flowering to help maximise pod numbers and seeds per pod.

The crop requires approximately 30 kg N/ha to build each unit of canopy, so will require about 150 kg N/ha for 90% light interception.

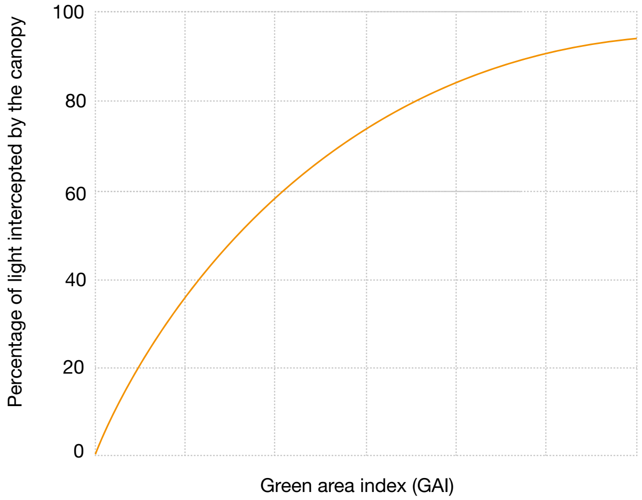


Figure 4.
Impact of GAI on light interception

Nitrogen and light capture

Nitrogen uptake and fixation rates decrease during grain filling in peas as nitrogen is relocated from the canopy to the seed. Crops with a high yield potential therefore need to accumulate nitrogen reserves and may benefit from growing a larger canopy to help meet the nitrogen demand of the seed.

Experiments have shown that leaves, tendrils, stems and pods all contribute significantly to light interception. For example, even tendrils have been shown to intercept 18% of light.

After flowering, more of the light is intercepted by pods and less by leaves as the leaves senesce. Therefore, it's important to maximise the health of all these plant parts to maximise seed size and fill.

Yield components

Yield components

The principal components of yield are seeds/m^2 and seed size. Seeds/m^2 results from a combination of plants/m^2, shoots per plants, pods per shoot and seeds per pod.

The development of each yield component occurs during different phases of growth, which means analysis of these characteristics can indicate when a crop may have been positively or adversely affected by management or conditions.

Unlike cereals, peas are indeterminate which means that vegetative growth continues after flowering. This means there is often substantial overlap and hence competition between the growth phases of each yield component (Figure 5).

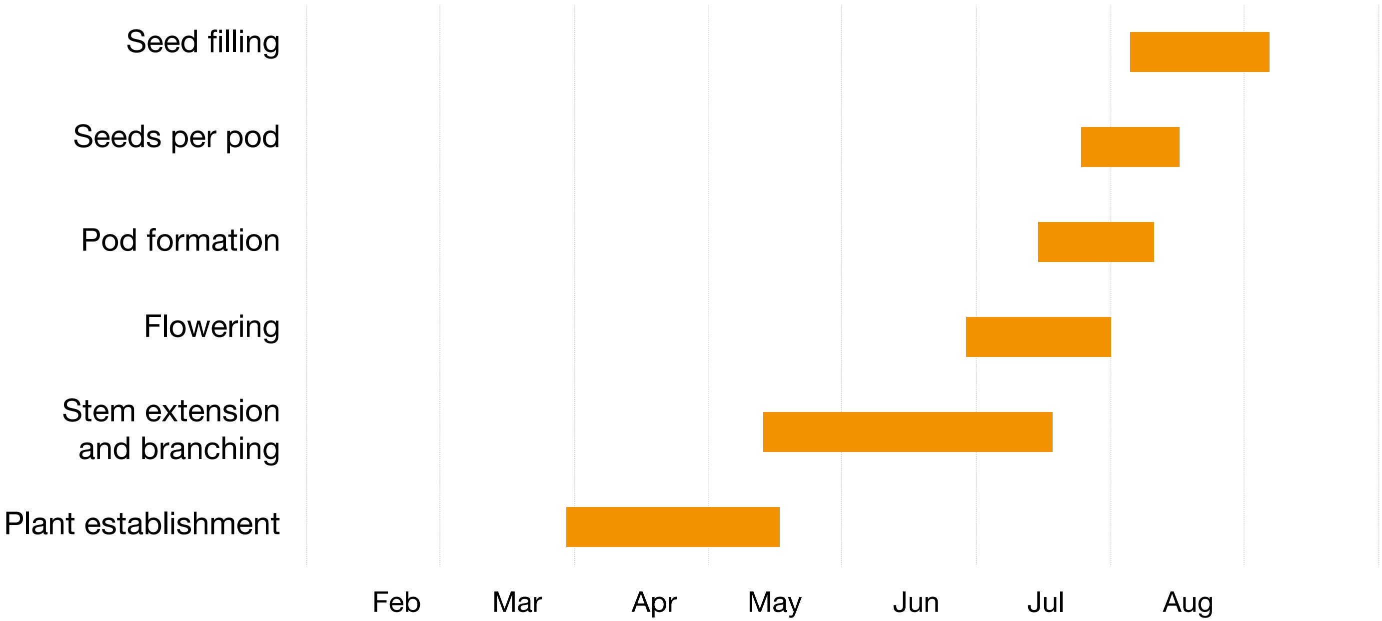


Figure 5.
Yield component development of peas through time

Plant population

Determined by seed rate and establishment.

Shoot number per plant

Determined during stem extension and influenced most by plant spacing and water supply.

Pods per shoot

Related to number of nodes per shoot which may be related to plant height and the conditions during stem extension. Flowers may be aborted under stressful conditions such as high temperatures, drought or dull conditions. Field peas are self-pollinating. The period between start of flowering and start of seed filling is defined as the critical period for field peas.

Seeds per pod

The final number of seeds per pod is also sensitive to the amount of photosynthesis during the critical period and seed embryos can be aborted under stressful conditions.

Seeds/m^2

A function of plant number, shoots per plant, pods per shoot and seeds per pod. Seeds/m^2 determines the sink size of the crop.

Sink size is mainly determined by seeds/m^2

with potential seed size also having an effect

Source size relates to the ability of plants to fill the sink

with potential seed size also having an effect

Seed size

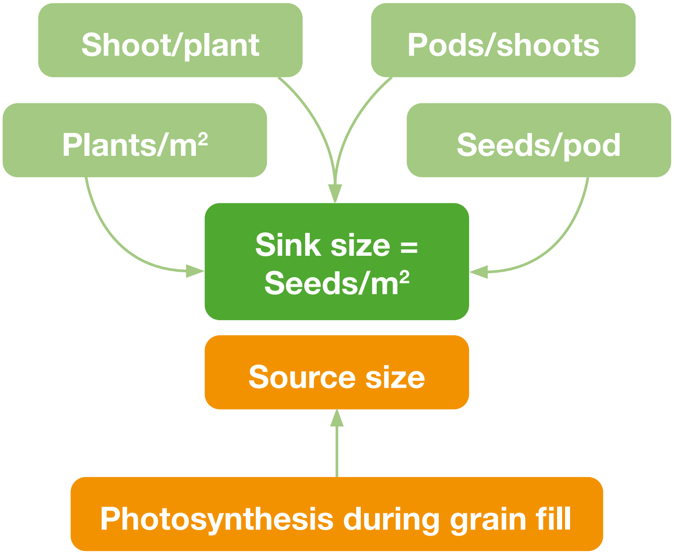
The seed's ability to reach its potential size is determined by the rate and longevity of photosynthesis during seed fill. This is described as the source size of the crop.

Variety affects most yield components

Source vs sink limitation

Analysis of BASF trials found associations with the number of seeds set per m^2 and yield. Analysis of the Pea Yield Enhancement Network (YEN) data set additionally shows positive associations between thousand seed weight (TSW) and final yield.

Therefore, both the number of seeds set (the sink size) and the ability to fill these seeds (the source size) are important factors in determining final pea yields.



Nutrient uptake

The proportion of nutrients partitioned between the seed and the haulm varies considerably by nutrient. The plant partitions a greater proportion of phosphorus, nitrogen, zinc, copper and sulphur to the seed, but less calcium, boron, potassium, manganese and iron.

The amount of nutrients taken up by a pea crop yielding 3.5 t/ha are about 160 kg/ha for nitrogen (N), 80 kg/ha for potassium (K), 14 kg/ha for phosphorus (P), 9 kg/ha for sulphur (S) and 10 kg/ha for magnesium (Mg) (Figure 6).

Diagnosing nutrient deficiencies

It is important to consider nutrient concentrations in the seed at the end of the growing season to help assess if the supply of nutrients was deficient (i.e. either due to inadequate supply or inability of the root system to access nutrients) or in surplus – and therefore whether there could have been environmental and financial benefits from applying fewer nutrients.

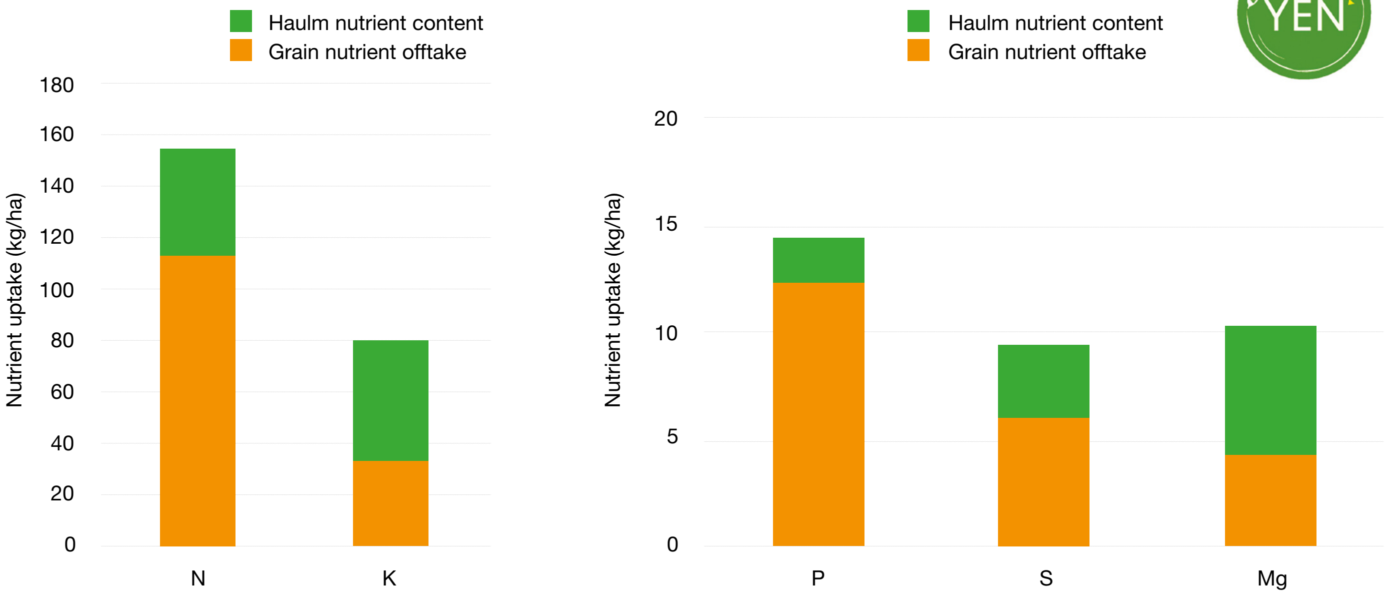


Figure 6.
Nutrient uptake for a pea crop yielding 3.5 t/ha (15% moisture)

Pea YEN ideotype:

- **Early flowering**
- **Tall, multi-noded stems**
- **Large sink size (seeds/m²)**
- **Deep roots**

The ideal traits for a high-yielding pea crop

The dataset collected from the Pea Yield Enhancement Network (YEN) (2017-2023) has highlighted that there are specific plant characteristics that are likely to be needed to achieve high yield.

From this, a high yielding 'ideotype' has been developed for peas. An ideotype is a combination of morphological and/or physiological traits that can be targeted to enhance crop yields. Characteristics may be influenced by genetics, environment and management conditions.

Analysis of the Pea YEN dataset demonstrates that high yields in both marrowfats and other combining pea variety types relate positively to:

- **Early plant establishment and earlier flowering**
- **Greater plant height, shoot biomass and pods per shoot**
- **More seeds per m^2 and, to a lesser extent, heavier seeds**
- **Greater harvest index - ratio of seed to total biomass**

Multi-noded, tall stemmed plants with deep roots are likely to prolong the flowering and pod-setting periods, improving resilience against conditions that may reduce pod set.

Influential husbandry and environmental factors for pea yields

The following environmental and husbandry factors have been identified as affecting the chance of achieving well established, multi-noded, high seed set and seed fill ideotypes, which lead to higher yields:

Establishment

YEN data has shown that earlier sowing and earlier plant establishment are associated with higher yields. Use a variety with high vigour and drill at an even sowing depth into good soil conditions that ensure good seed to soil contact.

Maximise pre-flowering growth

Tall plants with high biomass are associated with higher yields. This may be caused by the plants having more nodes for branches and flowers, as well as more nitrogen reserves.

- **Achieve full ground cover as early as possible through rapid plant establishment.**
- **Provide sufficient nutrients, especially phosphorus and sulphur, to allow the canopy to expand and fix nitrogen.**

Maximise water capture

Water stress can reduce pod set, seeds per pod and seed filling. Encouraging deep rooting to at least 1.0m depth is key for good water capture. This can be aided by minimising any soil compaction, achieving good seed beds and good soil structure throughout the soil profile.

Heat stress at flowering

High temperatures during flowering have been associated with lower yields in the YEN data. This is likely to be caused by reduced self-pollination and greater flower abortion. Having multi-noded stems with more pods will prolong the period of flowering, helping to compensate against adverse conditions.

Maximise green canopy duration

Maintaining a green and healthy canopy for as long as possible is key to maximising the capture of sunlight to fill the seeds.

- **Make use of disease resistant varieties and effective fungicides to prevent early canopy death.**
- **Make use of fungicides with physiological greening effects to prolong canopy life.**

Other husbandry factors associated with high yield in YEN

- **Regular manuring within the rotation**
- **Ploughing or deep non-inversion tillage**

Pea quality

Suitability for end markets

The quality of the harvested seed significantly influences end market suitability and therefore the premium achieved.

Variety type is the main determinant of end market suitability. Consult the PGRO agronomy guide and website for more information.

Once the most suitable varieties are selected and sown, it is then important to ensure that the crop reaches the required quality for the target end market.

New markets or end uses may develop over time. Remember that peas can also contribute to livestock feed on-farm.

Pea quality metrics

Seed merchants will measure a variety of quality metrics to determine end market suitability. It should be noted that some of these metrics will be less, or not, important for different end markets - consult the PGRO agronomy guide for more information on requirements and note the requirements of specific contracts. Explanations on the quality metrics are given below.

Colour & blemishes

This may include deviations from the pea seeds intended green colour for a number of reasons. For example, bleaching can occur if the colour of the skin lightens towards yellow/white. Staining may refer to darker blemishes.

Seed size

Can be compared to expected values through PGRO's descriptive list.

Typical thousand seed weights (TSWs) include: white peas 150-250g, small blues 150-225g, large blues >225g, maples >150g, marrowfats >275g.

Waste

Waste includes split or cracked seeds. Waste values reported may be combined with percentages of insect damage or stained seeds too.

Admixture

This includes soil, pods, weeds, stones and other species.

Soaking and cooking

Merchants carry out soaking and cooking tests to determine suitability for various markets. Methods and scales may differ between merchants.

Determinants of pea quality

As well as variety, crop management decisions and conditions during the season may influence quality. For example, analysis from the Pea YEN highlights associations between quality and weather conditions around harvest.

Colour & blemishes

The Pea YEN shows the proportion of bleached and stained peas are higher in wetter, cooler summers. Pea crops awaiting harvest in wet conditions may have pod walls that are thinner and more translucent leading to increased risk of sun damage and bleaching. Timely harvest where possible is most important to achieve the best quality. Crops that lodge in wet conditions with pods sitting on the ground are more likely to stain.

Seed size

This is largely a varietal characteristic and is also influenced by growing conditions, e.g. lower values may result if photosynthesis is limited during seed filling. The Pea YEN highlights lower TSW in hotter summers.

Waste and admixture

These metrics were not associated with summer weather conditions in the Pea YEN but they were negatively associated with yield. Proportionally, lower yielding crops tend to have more waste and admixture at harvest. Alternatively, yield, waste and admixture might all be affected by common factors such as lodging.

Cultivations and establishment techniques

Cultivations

Land is often ploughed in the autumn, allowing natural weathering to aid in the production of adequate tilth with minimal cultivations in the spring. Peas are sensitive to compaction. On lighter soils, spring ploughing is an option where over-wintered stubbles are required.

Rotation

To avoid soil-borne diseases, peas should not be grown more than 1 year in 5 on the same field. It is advisable to lengthen the rotation to 1 in 7 or 8 years in vining pea rotations especially where there is a history of foot rot.

Sowing

Peas sown in rows narrower than 20cm often result in higher yields since they tend to give more even crops, easier combining and better competition with weeds. Ample plant population is essential since low populations are more difficult to harvest, mature later and are more prone to bird damage.

Seeds should be sown so that they are covered by at least 3cm of settled soil after rolling. On most soil types it is necessary to roll the field to depress stones, avoiding damage to the combine, and providing effective pre-emergence weed control. Rolling should be done soon after sowing, but prior to the application of pre-emergence herbicides and well before emergence.

Patience

It is important that sowings reach the desired maturity in succession, providing a smooth progression in harvesting and processing, with a product of consistently good quality. The benefits of early drilling can include higher yield, earlier maturity and some escape from pests. However, it is more important to drill peas when soils are drier and less prone to compaction, so it is essential to be patient and wait until the time is right.

$$\text{Seed rate (kg/ha)} = \frac{\text{Thousand seed weight} \times \text{target population plants/m}^2}{\text{\% germination}} \times \frac{100}{(100 - \text{field loss})}$$

Seed quality

Seeds should be tested for germination, pests and diseases. Growers should note however, that there are no minimum infection standards specified by the statutory certification scheme for leaf and pod spot (*Ascochyta*). It is advisable however that pea seeds should contain no more than 5% infection with *Ascochyta*. Unlike combining peas, vining peas can suffer from seedbed losses due to low vigour and therefore can be tested for vigour using the electrical conductivity method.

Seed rate

For combining peas, the target plant population is between 65-110 plants/m^2 depending on variety, whilst for vining peas the target is 100 plants/m^2.

Establishment diseases

Foot rot

Foot rot diseases in peas are caused by a complex of soil-borne pathogens which produce long-lasting resting spores able to survive in soils for more than 10 years. The most common pathogens are *Fusarium solani* (Fusarium), *Didymella pinodella* (Didymella) and *Aphanomyces euteiches* (Aphanomyces). These pathogens can occur individually or in combination, and yield losses can be severe.

Development of foot rot diseases is encouraged by poor soil structure, compaction and water logging. Frequent legume cropping leads to the build-up of pathogen levels in soils.

To reduce the risk of a build-up of foot rot, peas should be grown on the same field no more than 1 year in 5 (ideally 1 in 7). There is limited information on whether the same pathogen strains can infect other legume crops.

Damping-off *(Pythium spp.)*

Peas sown early in spring when soil temperature is low and moisture high may be slow to emerge. This leads peas to be more susceptible to infection by soil-borne fungi, including *Pythium spp* (damping-off). Cotyledons decay and rootlets become infected. Seedlings fail to emerge.

The first sign of infection with damping-off is low plant density. The remains of the seed coat may be present in rows with the rotted cotyledon.

This disease significantly affects crop yield when conditions at establishment are conducive to high levels of infection, and poor establishment may lead to greater competition from weeds.

Reduce the potential of damping-off by planting into warm, free-draining soils that allow rapid germination and emergence. There are no seed treatments that prevent infection with *Pythium*.

Downy mildew *(Peronospora viciae)*

Primary infection of downy mildew in young pea plants occurs from the pathogen's resting spores, which persist in the soil. The resulting infected plants are stunted, covered on the underside of the leaves with grey/brown-coloured mycelial growth and often die before flowering. They are the source for secondary infection of older plants as they produce air-borne spores, especially under cool and humid conditions experienced in the spring. The pods of older plants develop yellow blotchy patches on the surface.

Unfortunately, there are currently no fungicidal seed treatments for peas which give effective control and standard foliar fungicides provide only partial control of secondary infection.

Leaf and pod spot *(Ascochyta)*

Leaf and pod spot is primarily a seed-borne disease which develops after a prolonged period of wet weather. The lesions of this disease are greyish-brown, circular to oval in shape and often develop a lighter grey centre. As the name suggests, lesions can spread from the leaf onto the stem and pod surface. This type of infection can also blemish seeds inside the pod. The most frequent species of leaf and pod spot is D. pinodes, which can cause losses in both yield and quality in wet conditions.

Using certified or tested seed is the best way to prevent infection. Whilst the disease is seed-borne, air-borne spores can also cause further infection resulting in more serious yield loss.

Establishment pests

Pea cyst nematode *(Heterodera gottingiana)*

Pea cyst nematode is a very persistent soil-borne pest, often causing severe yield loss. Affected plants are stunted and pale, and the root systems do not develop nitrogen-fixing nodules, but become studded with white, lemon-shaped cysts. Correct diagnosis is essential as subsequent pea crops grown in infested fields are subject to complete failure. Frequent cropping of peas and Vicia faba beans favours the build-up of infestations, and an adequate rotation is essential to minimise the risk of occurrence. There is no effective chemical control for this pest.

Pea and bean weevil *(Sitona lineatus)*

Weevil may cause damage if large numbers appear when plants are small and in particular in cloddy seedbeds or conditions of slow growth.

Pea and bean weevils are active in early spring where they migrate in from grassy, uncultivated edges of fields previously cropped with legumes. They begin feeding on the leaves, leaving characteristic ‘u’ shaped notching around leaf edges. Eggs laid by the female weevil whilst feeding are washed into the soil around the stem base and produce larvae. It is these larvae which begin feeding on the root nodules, causing most damage to yield.

Insecticide sprays can be applied at the first sign of leaf damage and repeated after 7 – 10 days, although there is resistance to pyrethroids in weevil populations. If sprays are ineffective, no further applications should be made.

Bean seed fly *(Delia platura)*

Late planted peas may be susceptible to larval feeding from bean seed fly during germination and emergence. Adult flies are attracted to freshly disturbed soils with high levels of plant debris or other organic material, and lay eggs on the soil surface close to where the seed is planted. After a few days, the eggs hatch and larvae feed on newly planted seeds. After feeding for 10-14 days, larvae pupate and emerge as a new generation of adults, flying to nearby susceptible crops. There may be several generations per year, and the flies have multiple crop hosts.

Larvae feed within the cotyledons, damaging the plumule and root. Tunnelling may occur in the plant stem and the growing point may be damaged. Peas may produce secondary shoots and maturity may be affected. Severely damaged seeds fail before emergence. Damage may occur in large patches as the flies aggregate before laying eggs and large numbers of seedlings can be lost.

Recent work has shown that leaving a period of at least 7 days between cultivation and drilling can reduce the amount of damage to peas. Damage can also be reduced by altering drilling timing to avoid periods of peak adult activity. Crops sown from mid-April onwards are most at risk.

Field thrips *(Thrips angusticeps)*

Thrips are tiny, narrow-bodied, black insects of the type known as 'thunderflies'. Many generations of thrips are wingless and spend most of the year in the soil, feeding on a wide range of non-legume hosts. In most seasons, damage caused by thrips to newly emerging pea crops occurs to a greater or lesser degree. Attacks are more severe during periods of slow growth and in particular on stony soils.

As peas begin to emerge in the spring, thrips feed inside the tightly rolled leaves of the growing point. As a result, young leaflets appear pale and slightly distorted and, if held to the light, small translucent markings are obvious.

In many situations, peas can outgrow the initial attack, with no long-term effects on the crop.

However, occasionally when the attack is severe, peas may develop multiple secondary shoots and develop as small bushy young plants. Thrips in peas may be difficult to control as the insects feed inside the enclosed shoots. Early treatment is essential and where thrip damage is confirmed as the peas are just emerging, and before the leaves have expanded, a single spray should be applied as soon as possible.

Weed control

Pre-emergence weed control

Yield can be significantly reduced when peas suffer from weed competition for light, nutrients and moisture during the critical establishment phase. This is why early weed control from herbicides applied pre-crop emergence is vital to maximise yield. The lack of herbicide options for post-emergence weed control also means that it is important to use strong pre-emergence herbicides such as Nirvana® and Stomp® Aqua to provide the required broad-spectrum weed control. Remember though, good pre-emergence weed control relies on the quality of the seedbed, soil moisture and product choice.

Nirvana®	Stomp® Aqua
• Two complementary herbicide modes of action for improved efficacy • Controls the widest range of grass and broad-leaved weeds (e.g. annual meadow grass, poppy, fat hen, charlock, black bindweed, knotgrass, etc.) • Good residual activity to cover germination periods of key weeds • Flexible on rates according to weed spectrum and pressure • Range of tank mix options	• Excellent base on which to build the herbicide programme • Physically compatible with a wide range of pre-ems • Strong residual activity • Non-staining, easy rinse formulation • The most efficient formulation of solo pendimethalin • Optimised pendimethalin formulation means less packaging waste

Pre-emergence rate recommendations

Crops	Product	Rate	Comments
Combining and vining peas	**Nirvana®** (250 g/l pendimethalin + 16.7 g/l imazamox)	4.5 l/ha	Broad spectrum and long lasting for moderate to high weed populations
		3.0 l/ha	Rate for use in tank mix for moderate and lower weed populations
Combining peas	**Stomp® Aqua** (455 g/l pendimethalin)	2.9 l/ha	Ideal base tank mix partner product for grass and broad-leaved weed control
Vining peas (EAMU)	**Stomp® Aqua** (455 g/l pendimethalin)	2.2 l/ha	

Application advice for pre-emergence weed control

1. Good seedbeds and soil structure benefit both crop establishment and the performance of pre-em herbicides
2. Don’t use on water-logged soil or soils prone to waterlogging
3. Fine, firm seedbeds improve seed to soil contact which improves germination and establishment
4. Level and consolidate loose, cloddy or open tilth before spraying pre-em herbicides
5. Do not apply where the seedbed is stony, rough, cloddy or open, or when heavy rain is forecast
6. Clod-free seedbeds also aid efficacy and crop safety of pre-em herbicides
7. Ideally apply within 48 hours of drilling
8. Drill to a minimum depth of 25mm and ensure seed is fully covered with settled soil

Post-emergence weed control

Post-emergence weed control options are limited. Bentazone and MCPB are the only approved active ingredients. Bentazone, such as in Basagran® SG offers useful follow-up control of cleavers and volunteer OSR. For maximum efficacy, apply when weeds are small. Water stewardship should take high priority when applying bentazone due to its water solubility.

‘Know Your Bentazone Risk’ is a cross-industry stewardship programme aimed at promoting sustainable on-farm water stewardship through tools such as the ‘Crop Planning and Bentazone IPM Tool’.

Crops	Product	Max Rate	Timing	Comments
Combining and vining peas	**Basagran® SG**	1.1 l/ha	Post-em before flower buds can be found in terminal shoot	Broad leaved weeds only and apply to small actively growing weeds. Follow Water Stewardship Guidelines.
	Laser®	2.25 l/ha	Post-em up to 5 weeks before harvest	Grass weeds only and apply with adjuvant before canopy prevents spray penetration.

Know Your Bentazone Risk

At present, bentazone is the only post-emergence herbicide for broad-leaved weed control in beans and one of the few post-emergence herbicides in peas to control some challenging weeds such as black nightshade.

Basagran® SG

BASF's Basagran® SG offers broad leaved weed control with bentazone.

Key benefits

- Reliable R&D manufacturer
- Full technical support
- Single or split-dose recommendations

Water stewardship

Bentazone is a highly soluble compound in water and is very mobile in soil which has resulted in it being detected in both ground and surface water. Securing the future of bentazone has to come from improved farm and field practice.

Every person who is applying bentazone, irrespective of the area, has a responsibility to maintain high levels of stewardship and help improve water quality.

All pathways matter and everybody can help to prevent and minimize the risk.

Top tips to reduce the risk of bentazone entering surface and groundwater

1 Ensure the field is suitable before planting the crops
Check your soil type to see if you are at a high risk of chemistry leaching through the soil.

2 Avoid high risk areas
Use our mapping and planning tool to help you choose the best site to avoid high risk areas.

3 Keep chemistry on the surface
Avoid spraying your crop on wet days or when there is significant water sat in the field.

4 No spray zone
Having a 6m buffer zone/5m no spray zone around the edges of the field will help where there are high risk areas.

5 Consider how and where you fill the sprayer
Take care when handling the product, filling and cleaning the sprayer to avoid leaks or spills.

Scan the QR code to learn about our Crop Planning and Bentazone IPM Tool

Flowering pests

The pea aphid *(Acyrthosiphon pisum)*

Attacks by aphids may result in loss of yield by spoiling flowers, causing failure of pods to fill and by generally reducing plant efficiency. Aphids transmit viruses and produce honeydew, an ideal medium for colonisation by saprophytic fungi, in particular the sooty moulds.

Colonies form quickly as the female needs no male for fertilisation, and bears living young at a rate of 15 per day in suitable conditions. Eggs over-winter on forage crops, hatching in the spring to give wingless stem mothers. These produce spring colonies of wingless females, which in turn produce winged females that cause damage in the summer. As the pea plants deteriorate, the colonies produce winged female migrants that move to other plants to produce new colonies. Later in the season, winged females move to over-wintering host plants where they produce males and females that lay eggs on the winter hosts.

Where virus is known to cause problems in peas, crops should be sprayed as soon as aphids are present. Whereas, to prevent direct feeding damage, it is recommended to spray combining peas when 20% of plants are infested and vining peas when 15% of plants are infested.

Pea midge

Midges emerge from previously infested fields in late spring and early summer, and after mating, the females fly to pea crops during the later part of the day. Females lay eggs on developing flower buds and eggs hatch after 4-5 days.

The larvae enter the developing buds where they live and feed at the base of the ovaries. The buds become swollen and gouty and do not produce pods, thereby resulting in loss of yield. Larvae may also feed in the clustered leaves of the growing point and the top of the plant remains shortened and develops a ‘cabbage’ or ‘nettle-head’ appearance. In wet periods, the damaged tissue may also provide a site for infection by fungi such as *Botrytis spp*. After another 5-7 days, the larvae are mature and fall to the soil where they form a cocoon and begin winter diapause.

Pea midges emerge over a short period, making detection and control difficult. A pheromone trap system is available to monitor activity and emergence in the previous years’ pea field (often cereals as shown in the image on the left). Sowing peas in areas adjoining previously infested fields should be avoided where possible since attacks by this pest may result in serious loss of yield.

Crops in which the majority of flowering is over and where pods have set will not suffer yield loss, but if attacked would contribute to the increase in the general level of midge population in the area.

In areas of high incidence of attack, spraying of vining peas is recommended shortly after midges are observed in traps at threshold levels (500 midges per trap) and in crops at the susceptible growth stage, enclosed bud.

Pea moth

Pea moth is one of the most damaging pea pests in this country and across Europe. The larvae feed on peas within the pod. Although moth damage reduces pea quality, the yield loss is rarely significant and the presence of damage in peas for animal feed compounding is not important.

Spraying should be related to the development of the insect rather than to the stage of growth of the crop and therefore insecticides should be applied while the larvae are exposed. Since pea moth can be a localised problem, overall spraying of peas over a wide area on any one date is not advisable as local conditions influence the behaviour of the pest. A system of accurately timing the application of insecticides is commercially available in the form of pheromone traps, combined with a simple model provided by PGRO to predict egg hatching.

Viruses

Pea seed-borne mosaic virus

Pea seed-borne mosaic virus (PSbMV) is a virus that is transmitted in a non-persistent manner in peas and that leads to high yield losses in some cases. The virus is primarily seed-borne but is transmitted by several aphids including the pea aphid, black bean aphid and peach-potato aphid.

The virus becomes established after using infected seed and is transmitted by winged aphids early in the spring. Symptoms include vein-clearing, narrowing and downward rolling of leaflets and foreshortening of the apical internodes. Pods at the upper part of the plants may be stunted and appear to have a glossy green appearance. As the peas mature inside the pod, a white blistering may develop, giving the peas a ‘tennis-ball’ marking over the seed coat.

The virus affects quality in vining peas, and it is important to maintain disease-free seed stocks. PSbMV can be detected in seed using an enzyme linked immunosorbent assay (ELISA) test, although not all infected seeds give rise to infected seedlings.

Pea enation mosaic virus

Pea enation mosaic virus (PEMV) is a virus that can potentially lead to 30-50% yield loss in peas and field beans. PEMV is persistently transmitted by aphids and is likely to have a greater effect on the crop if transmitted before flowering occurs. Therefore, controlling aphids when they first move into crops is most effective to prevent serious infection.

Symptoms of PEMV are apparent from late flowering onwards and include vein clearing, crinkled leaflets and the formation of translucent spots which are apparent when infected leaves are held up to the light. Often the tops of the plants become yellow and mottled with distorted leaves. Development of stipules is often retarded, and they remain very narrow. Pods may be severely malformed and fail to fill. The appearance of enations, small, irregular, protruding ridges of plant tissue which are found on the undersides of leaves and on pods, indicates an advanced stage of infection. Efficient control of aphids reduces the risk of losses.

Turnip Yellows Virus

Turnip Yellows Virus (TuYV) is a virus that can lead to 45% yield loss in peas. The virus was recorded in UK peas for the first time in 2019, although it is thought to have been present in peas in the UK for some time.

In many cases the virus does not cause clear symptoms in peas, and further work is required to determine the symptomatic effects that lead to yield loss.

This virus is known to cause high yield loss in oilseed rape and was the most prevalent virus in peas in a survey between 2019 and 2022. TuYV has a wide host range, including brassicas and legumes. Stunting and yellowing have been previously associated with TuYV infection, although this is not always the case.

TuYV is persistently transmitted by aphids and is not known to be transmitted by seeds or mechanically.

Flowering diseases

Sclerotinia *(Sclerotinia sclerotiorum)*

Sclerotinia is favoured by warm, wet conditions. Infection occurs during flowering where infected stems become covered in white mycelium and may collapse, often bleaching as they desiccate, with upper plants wilting and dying. The fungus produces a fluffy white mycelium over the infection site. Black, elongated sclerotia develop within the stem or on pods and these can contaminate the harvested produce.

For disease reduction, include at least one non-host crop within the 5 year rotation and apply fungicides when optimum conditions for sclerotial germination and infection are present.

Grey mould *(Botrytis spp)*

The fungus is attracted first to wet flower petals which, after pod set, either become detached and lodge in the leaf axils or remain stuck to the developing pods. Once *Botrytis* comes into contact with green plant tissue via the rotting flower petal, it can penetrate and cause a rot of the stems or pods. Infected stems die prematurely, and pods may either abort, or the disease can rot the seeds within the pods and the pod itself.

As well as a direct effect on yield, produce may be blemished, thereby reducing the quality of peas for processing or for seed.

One or two applications of fungicides at first pod set as flowers fall and at the flat pod stage may be required to prevent *Botrytis* infection when wet or damp weather occurs during flowering. However, in dry conditions, sprays during flowering are unnecessary.

Powdery mildew *(Erysiphe pisi)*

Late maturing crops may become covered with a grey-white film of powdery mildew. The disease can delay maturity but several commercial varieties are resistant to powdery mildew. Sulphur formulations such as Thiopron, Microthiol Special and Vertipin can be used under EAMU approvals to control powdery mildew

Pea bacterial blight *(Pseudomonas syringae pv. pisi)*

Pea bacterial blight is a seed-borne bacterial disease and may survive on crop debris. Symptoms appear at any time, especially when plants are physically damaged by frost, pests or machinery. Small, irregular-shaped brown lesions appear on leaves and stems and may form a fan shape on leaves.

When plants have been severely damaged and the weather is wet, the disease can spread rapidly, causing plants to collapse and leading to significant yield loss.

Some varieties may be more resistant to pea blight, but there is no chemical control once the disease is established. Seed health should be checked to prevent infection and if infected seed is harvested it should not be grown.

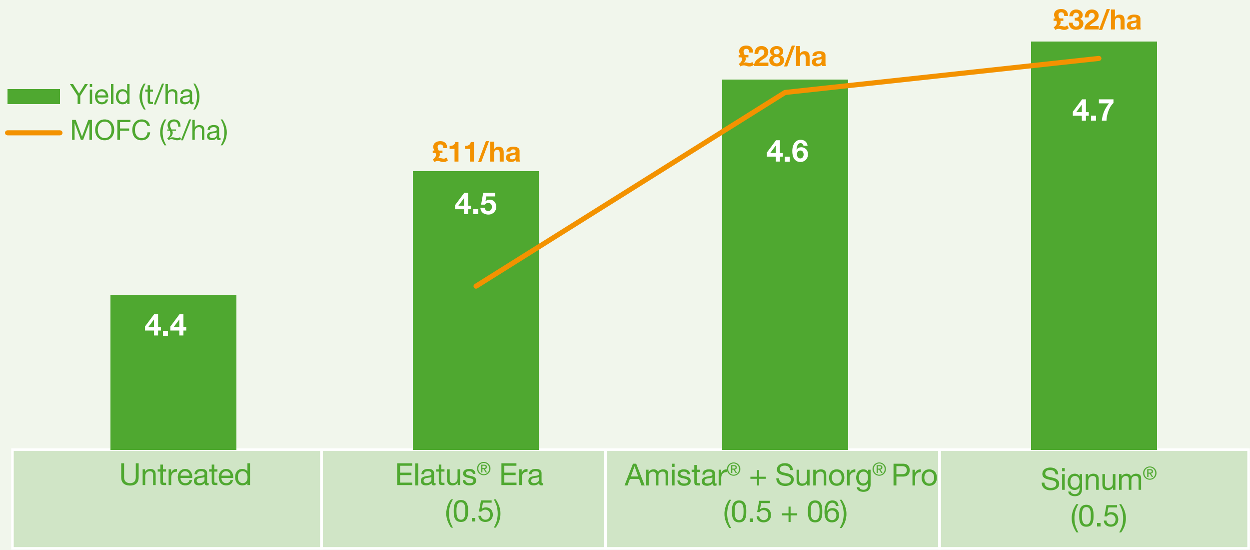
Disease control and Signum®

Protect your field, protect your yield

Signum®'s excellent disease control helps to maximise pea yields by stopping Botrytis and Rust in their tracks, whilst also prolonging green leaf area, and providing the best return on investment compared to alternatives.

Signum® maximises yield potential and crop quality

Signum® maximises yield even in the absence of disease, as displayed in the trial below (Figure 7) where Signum® provided a 7% yield uplift of combining peas.



N=1, 2024, E.Yorks, combining peas cv. Mikka
Treatments applied at beginning of flowering

Untreated yield 4.37 t/ha
Kynetec average farm prices 2024. Peas £230/t

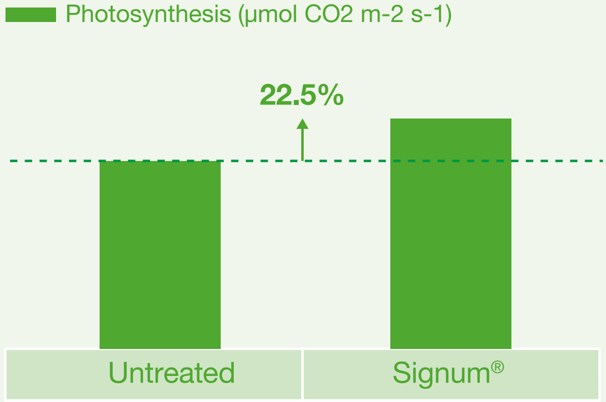
Figure 7. Combining peas yield increase when using varying fungicides

Key benefits

- Delivers excellent, long-lasting disease control of Grey Mould, Rusts and Sclerotinia in peas
- Provides the best return on investment
- Builds yield potential and crop quality
- Provides physiological benefits from both boscalid and pyraclostrobin, resulting in increased green leaf retention throughout the season and reduction of stress

Signum® increases photosynthesis post-flowering

In recent ADAS crop physiology studies, Signum® provided a 22.5% increase in photosynthesis which resulted in a 9% increase in yield as seen in Figure 8.



ADAS Pea Physiology Studies
2022-2023, N=3, combining peas

Figure 8. Effect of Signum® on photosynthesis for combining peas

Rate and timing recommendations

Product	Application Rate and Timing	Harvest Interval
Signum®	At the first sign of disease or max flowering/1st pod stage, apply 0.5 to 0.75 kg/ha in a minimum volume of 200 litres water/ha. For combining peas, a second application 2-3 weeks later may be necessary, depending on disease pressure	Combining peas 21 days, vining peas 14 days
Sunorg® Pro	Best used as a second spray. Where disease pressure is low, use at 0.4-0.6 l/ha. Where disease pressure is high, use at 0.6-0.8 l/ha	14 days

Disorders

Marsh spot/manganese deficiency

Manganese deficiency can reduce yield and may result in the appearance of marsh spot, a necrotic blemish of the seed. The resulting produce is unsuitable for human consumption, and for use as seed since the resulting seedlings are often weak and malformed, with multiple shoots and short-lived growing points.

The disorder is commonly associated with organic soils, with a soil pH of more than 6.8 likely to give a problem. This is especially a concern in wet or compacted conditions.

Manganese deficiency causes a yellowing around the leaf edges and between the veins, with the peas produced developing a brown and often granular area in the flat faces of the cotyledons (a marsh spot).

It is recommended to treat crops which are growing on land known to have a history of manganese deficiency and/or on land of pH 6.8 or more as routine, spraying at the 1st pod stage and again 10-14 days later. Crops in which symptoms are seen should be sprayed immediately and treatment repeated at the 1st pod stage and about 10 days later still.

Vining Peas - highlighting key differences

Vining peas are grown for the fresh vegetable and frozen pea market, whereas combining peas are grown for animal and human feed and are harvested later when the peas are fully ripe and hard.

There are some differences in the agronomy for vining peas, including them being more susceptible to seedbed losses due to low vigour and having a different seed rate to combining peas. However, the main differences lie within the herbicides and fungicides that are approved for use and the dose rates, which have been mentioned previously in this guide.

For pre-emergence weed control, Nirvana® can be used similarly on both combining and vining peas, however when using Stomp® Aqua, a reduced rate of 2.2 l/ha is recommended on vining peas.

With regards to fungicide application, both Sunorg® Pro and Signum® can be used on vining peas as well as combining peas. However, when applying Signum®, a reduced harvest interval of 14 days is recommended for vining peas.

Perseus® can also be applied to vining peas as a protectant fungicide for *Ascochyta* blight and leaf and pod spot.

Additional resources

Bean Growth Guide

Scan QR code for more information

PGRO Online Pulse Agronomy Guide

Scan QR code for more information

Pea YEN

Scan QR code for more information

Further information:

Thank you for reading the BASF Pea Growth Guide, produced in collaboration with PGRO & ADAS. Please see below for further information.

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@BASFCropUK

PGRO: pgro.org
@pgroresearch

ADAS: adas.co.uk
@ADASgroup

Disclaimer

Basagran® SG contains bentazone. Nirvana® contains imazamox and pendimethalin. Laser® contains cycloxydim. Perseus® contains difenoconazole and fluxapyroxad. Stomp® Aqua contains pendimethalin. Signum® contains boscalid and pyraclostrobin. Sunorg® Pro contains metconazole. Amistar® contains azoxystrobin. Elatus® Era contains benzovindiflupyr and prothioconazole.

Use plant protection products safely. Always read the label and product information before use. For further product information including warning phrases and symbols refer to www.agricentre.basf.co.uk.

For further information, please do not hesitate to contact your local BASF Agronomy Manager or the BASF Technical Services Hotline: **0845 602 2553.**

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