# Cultivation

## Seed Quality

*Quality is an ongoing theme throughout the whole seed production process.*

**Why is seed quality important?**

Seed producers want to produce the best quality seeds. As growers we know that good quality seeds will show better germination rates and store for longer. They produce healthier plants with a greater resistance to pests and diseases and will produce a higher yield.

- **Important in organic horticulture**.
- **In general, the fatter, heavier and the more mature the seed, the better the quality**.
- As well as quality of the individual seed, quality could also be described as 'purity' of the harvested seed stock as a whole.
- **A final stock of good quality seeds will have a high percentage of 'pure' seeds and very low proportion of, inert substances.** E.g. parts of unviable seed, seeds without seed coat, soil, small stones, fungal bodies and weed seeds.

## APHA

Animal and Plant Health Agency.

HSL functions as a part of non-profit conservation charity and the seeds that we conserve are not listed on the UK national list and for this reason we cannot sell them. However, we have found that a few of our varieties have been listed as amateur varieties. When this happens, there is no need for us to conserve them so we could potentially sell them. However, in order to sell those particular seeds we would need to:

- **Register with APHA** and obtain a licence to market seeds.

- Have our growing site inspected by APHA once a year and have a sample of seed tested for ‘purity’. Purity tests involve quantifying the proportion of pure seed in a sample to inert non-seed. It may also involve growing a selection of the seed to see whether the seed sample follows the description for the variety.

- Seeds certified in this way are showing that they meet UK quality standards.

# Healthy Seed Crops

***Healthy plants equal healthy seeds.***

*Cultivation is an extremely important factor in seed quality. Providing optimum growing conditions for your crop will produce healthy and vigorous plants to save seed from. Stressed plants will produce flowers and seeds as a last-ditch survival mechanism but the seeds will not be of the best quality.*

**Knowledge of your growing site, climatic conditions and seed crop requirements:**

- **Seed crops need a longer period of time to grow**, set seed and produce mature, ripe seed.

- **Can your site accommodate this?** If not, crop protection early and late in the season can help. E.g. frost protection for tender vegetables early in the season or protecting drying seed crops from excessive wet conditions late in the season.

- **For a UK climate we recommend growing tomatoes, melons, aubergines and peppers under cover** for seed to ensure a long growing and ripening season.

**Only sow from the best quality seeds:**

- Seeds that are free from any visible damage to the seed coat.

- Reject seeds that are undersized, wizened, water damaged, or have abrasions to the seed coat and split seeds.

**Soil health and fertility:**

Seed crops are in the soil for longer and have greater nutritional demands. E.g. some brassicas remaining in the same spot for two years.

- **Having a good rotation** will help protect the soil**.**

- **A soil test** is useful way to determine any accurate nutritional deficiencies.

- **Using green manures** to improve soil structure and microorganism activity after a seed harvest and providing fallow periods to rest the soil.

**Water and temperature** can affect plant growth, pollination rates and mature seeds drying properly:

- **Excessive heat** in sealed poly tunnels can reduce pollination. Hot conditions cause flower drop on broad beans and runner beans. Fertilisation of tomato flowers is seriously reduced during long periods of heat in the day and night. Having poly tunnels with mesh sides, growing cool weather crops as early as possible and poly tunnel fans can help to reduce temperatures.

- **Low and high temperatures also effect pollinators**, as they become less active.

- **A period of vernalisation is needed for biennial crops.** This naturally occurs in unheated (but frost free) winter storage during a 'normal' U.K. winter.

- **Too much water and high humidity when seed pods are drying** can damage seeds and encourage fungal infections. In poly-tunnels, significantly reducing the amount of irrigation when seeds are starting to dry will help.

- When growing outside, you can add water but not take it away as easily. Putting temporary waterproof covers over a seed crop will reduce the damage from too much rainfall.

**Good air circulation:**

- **Solid plant supports and spacing** help with this.

- **Weed control**, excessive weeds will reduce air circulation and also contaminate the final harvest with weed seeds.

- **Green manures and companion planting.** Growth should be kept low or limited to a certain area in very humid poly-tunnels to make sure air can circulate around the crops.

# Seed Pests & Diseases

*In general, pests and disease problems can significantly weaken plant health and in consequence seed quality. There is also the potential for diseases be carried on to the next generation through infected seed.*

**Some Examples.**

**Moulds and fungal infections:**
Are problematic at the end of the season if there are damp conditions as seed crops begin to dry.

- ***Sclerotinina* disease** can thrive in unventilated conditions under an isolation cage or poly-tunnel and seriously affect developing pods.
  **Things that can help reduce the risk**.
  Good air circulation around the plants and developing pods.
  Removing a small quantity of lower leaves on French and runner beans, stopping the growth at the top of the canes and removing a small number of leaves around the pods. Some French beans will lose their leaves naturally as the pods mature.
  Good hygiene, removing any infected stems, gently shaking plant free from loose petals and dead leaves and removing them from the soil.

  Further information can be found here.

- **Botrytis and fungal infections.** On heading lettuce and brassicas, as the seed stalks begin to elongate, they can become trapped under the tight ball of leaves that are produced by heading cabbages and lettuce and rot off. Making space for the emerging seed stalk by cutting a cross in the head or by gently prising the leaves apart will prevent this. Whole cabbage heads can be removed to make way for the seed stalk.
  Lettuce is particularly susceptible to botrytis, removing lower leaves and leaves on the seed stalk will improve air flow and reduce the likelihood of infection.

**Moths and caterpillars:**
Covering crops with fine mesh at the start of the season is the best way of reducing moth damage,isolation cages also work well.

- **Cabbage white butterflies.** Deplete leaves on the crop and weaken it so much that it doesn't grow enough to successfully store over winter.

- **Leek moth** can devastate seed yield by eating and travelling up inside the seed stalk up into the flower head. The flowers drop off and fall away.

- **Parsnip moth**. Only ever seen on seed crops of parsnip, wild parsnip and hogweed. Further information can be found here.

- **Pea moth**. At the immature green pod stage, you may notice small holes with a powdery deposit round them in some of the seed. This is a sign of pea moth. Pea moth lay their eggs on pea flowers, the larvae hatch and burrow inside the pod. Further information can be found here.

**Rodents:**

- Eat over wintering biennial crops, in and out of the ground. Chicken wire around the storage containers and sealing storage areas prevents rodents getting to your crop.

- Rodents also eat broad beans and peas at the start of the year.

**Bean weevil:**

You may notice small holes in your harvested beans. These are caused by bean weevil, or bean seed beetle, larvae. Further information can be found here.

**Lifecycle:**
The beetles lay their eggs on the pods and the larvae burrow into the developing seed. Mostly they feed on the coteleydon (embryonic leaf) but they can devastate your crop of beans if they eat the endosperm (tissue that surrounds the embryo) away when they hatch. If they begin to feed on the endosperm the bean will not germinate. Adults often emerge in storage and can complete several generations before planting time.

**Control:**

- Remove all trace of any beetles you may find.

- All stages can be destroyed by a 7-day minimum stay in a domestic freezer, without damaging the seeds. Ensure that the beans dry out fully afterwards before storing them.

- Hand podding when seed cleaning allows any infested seeds to be identified and discarded.

- As long as the embryo is not attacked and the seeds no longer contain any beetles, they will still germinate so, despite looking unsightly, can be kept for home use.

**Scarid Fly:**

- Scarid fly is often found living in untreated organic composts and in very wet compost.

- Larvae eat away large seeds of vegetables such as, pea, beans and cucurbits causing very no/low germination rates or very weak plants.

- Bio-controls available. Beneficial nematodes *Steinernema feltiae* work well if the soil is above 10 degrees Celsius and there is a large infestation. *Hypoaspis miles,* mites work well for lower numbers of scarid and a soil temperature above 12 degrees Celsius.

- Good hygiene is needed to clear away any soil debris in plant propagation areas.

- Avoid overwatering.

**Aphids and sap sucking insects**:

- Weaken plants also potential carriers of viruses between varieties.

# Seed Borne Diseases & Pathogens?

*How do we know when a disease or pathogen is seed borne or not? If pathogens have an 'early start' by being already present on the seed when it's sown they will have a much greater effect on the emerging plant.*

- **Having clean seed is important** and if a pathogen is seed borne potentially the whole crop will need to be removed and the seeds from which the plants were sown. The plants shouldn't be composted and modules, pots etc. should be thoroughly washed.

- **Spotting these issues at the earliest possible stage is important** because it could spread to other varieties. If seen in seedlings and in young plants, there may be time to re-sow from a different batch of seeds.

- **It is best to err on the side of caution, if there is any doubt remove the crop and batch of seeds.**

**Methods of detection:**
*Without any on site testing facilities the main way of detecting that there is a problem is by visual means and by knowing what potential pest and disease problems there are*.

**Visual means. Looking at the health of the seed we sow:**

- **Inspection of dry seed** can detect that a seed- borne pathogen may be present due to discolouration of seed coat or changes in the seed size and shape.

- **Low germination rates** in 'young' seed.

- **Poor vigour and health** of the seedlings.

- **Any abnormalities during growth.**
  E.g. very weak, wizened and twisted growth, necrotic/ brown patches on leaves, yellow patches on and between leaf veins, unusual fasciation.

- **A low powered microscope** can detect insects, eggs, fungal fruiting bodies (e.g. sclerotinia) and bacterial masses. If UV light is used certain fungi can be detected through fluorescence. Not conclusive or specific only indicative.

- **Seedling grow outs are** used mainly for bacterial detection but also many legume viruses are also expressed at the seedling stage. It can measure a seed batch's ability to transmit a disease. In terms of identification, is non-specific but could identify a potential problem. Pathogen populations on seeds can be low and not uniformly distributed so a large grow out is needed to reliably identify diseases and a controlled environment is required for consistent results.

- **Incubate pathogens on selective media by sterilised seed or seed washings.**
  Place seed on moist, sterilised blotters and incubate for a specific time and temperature determined by the suspected pathogen present. Fungus spores are removed from the seed by washing. These washings can be examined under the microscope or incubated on agar with UV light with a specific incubation time, temperature and intensity of light.

**On Site Testing:**
*It can be very difficult to identify the specific problem solely by visual means especially if you suspect a viral infection.*

- **There are on site diagnostic kits** for several mosaic viruses of, cucumber, maize, melon and pepper available to buy from various companies.
- **NIAB** (National Institute of Agricultural Botany) has seed testing centres that can test for various pathogens.
    - **PCR** Polymerase chain reaction detection. A DNA based detection system of certain pathogens. Accurate when it works *but can have difficulty extracting good quality DNA.*
    - **BIO PCR & IMS PCR** more accurate.
    - **ELISA** Enzyme linked immunosorbent and/immunofluorescent microscopy. Specific antibodies are generated by antigens on the surfaces of pathogens which can then be detected by enzymatic digestion or fluorescent tags.

# Seed Treatments

*There are some organic seed treatments available to reduce bacterial and fungal pathogens.*

**Hot Water Treatment:**
Hot water treatment immerses seeds in hot water at a certain temperature and for a specific length of time to kill or reduce pathogens. It should not have significant effect on seed viability, vigour and germination rates. Different vegetable species will vary in their sensitivity to treatment so temperature and length of immersion need to be vegetable specific. Some species are not suitable for hot water treatment.

- Due to risk of damage seeds it is recommended that seeds are treated only if there is known pathogen risk and high initial viability (e.g. more than 95% germination).
- **Can only be used on small seeds not beans, peas or most cucurbits.**
- It will treat pathogens on and inside the seed.
- Need to be very careful not to damage the seed.
- Should only be used if the seed is going to be grown in the following season since seed storage viability is reduced after hot water treatment.

Further information can be found here:

**STOVE** Seed Treatments for Organic Vegetable Production:

- Investigated physical and biological methods of seed treatment (alone and in combination).

- **Physical treatments** included hot water, hot air and electron treatment.

- **Biological methods** included microorganisms and plant extracts.
  Either act as a 'tonic' improving a plant's resistance to a pathogen or reduces infection.
  E.g. Bacillus subtillis – MBI600 and Thyme Oil - Milsana
  Suggestions also include using compost teas to treat surface pathogens

Further information can be found here.

# Cultivation Record Keeping.

**Integrated Pest Management (IPM) Plan:**

- **Provides a preventative rather than reactive approach** towards a potential pest or disease.

- Predicting which pest and diseases are likely to occur allows you to have preventative plans already in place.

- Provides methods for monitoring crops and allows you introduce controls at the most effective time. For example, introducing bio-controls at the correct temperature, light and levels of infestation.

- **Factor in additional seed production pest and diseases** into an existing plan or create a plan from your knowledge of your growing area.

- **Update it every year** and adding any problems or solutions.

Further information can be found here.

**Grow Out Sheets:**
*If you detect a problem such as cross pollination or a potential seed borne pathogen, grow out sheets help you trace back to a specific seed batch. If you have enough viable seed you can then use an older unaffected batch.*

- Each generation of seed is given a batch number.
- Record each year, which batches of seed have been sown, the number of seeds sown and the final population size.

# Seed Recovery after Storage.

**Recovery after Freezing:**
For a longer shelf life, some seeds can be frozen. *More on the practicalities of this can be found in the Harvesting and Cleaning Webinar and the Cleaning and Storage Toolkit.*

- **Not all seeds (e.g. parsnip) recover from freezing** but many will.
- **One of the key factors is the quality of the seed.** The better the quality, the more likely that a seed will survive the freezing and thawing process.
- Recovery after freezing allows the seeds to gradually reach room temperature before opening.
- **Allow seed to 'rest' for a few days** to reabsorb moisture to ambient humidity.

**Recovery after storage of peas and legumes:**
Dormancy or hard seed coats in peas and legumes is quite common. The seed forms a hard seed coat which is impermeable to water or the exchange of gases that initiate germination.

- The easiest way to see which seeds show this feature is to soak legume seeds in warm water for a day and identify which seeds have expanded and absorbed moisture.

- If many seeds haven't expanded, chipping or gently cracking the seed helps water and gases to be absorbed.

- Once the seeds have absorbed water, take out of the water and sow straight away.

# Germination Testing.

*A germination test is performed to determine what proportion of seeds will germinate under favourable conditions (moisture, certain temperature, light and oxygen) and produce normal seedlings (seedlings that have the essential structures—roots, shoots and sufficient food reserves) capable of development into reproductively mature plants.*

**Equipment for warm germination test:**

- Autoclave for sterilising tools and larger containers only (not petri dishes, they will melt).

- Seed cabinet germinator (default 20oC)

- Standard germination containers e.g. petri dishes and takeaway containers.

- Disc paper for petri dishes for small seeds up to cucumber sized.

- Concertina paper for large seeds e.g. peas & beans.

**Methods of germination testing:**

**Concertina method:**

- Put a few layers of paper towels on the bottom of the container and make concertinas out of more layers of towel and put them on top.

- Wet and then drain them. They should be wet but not soaking. The larger the seed, the more water is will need to germinate.

- Place the seeds between the concertinas and put another layer of wet paper towel over them.

**Top of paper petri dish method:**

- Place 2-3 layers in petri dish & follow above

Use a test log sheet to record the number of seeds that have germinated over a set period of time and frequency.

**How many seeds should be tested?**

- **A fixed-sample size germination test using 200** seeds is recommended to determine viability at the beginning of storage.

- If the test results show that germination is below 90%, an additional 200 seeds should be tested using the same method.

- Overall seed viability is taken as the mean of the two tests.

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