

LEAVING CERTIFICATE
AGRICULTURAL SCIENCE

Potatoes

LEARNING OUTCOMES

- Family
- Potato seeds
- Soils and Climate
- Place in rotation
- Varieties.
- Seed Bed Preparation
- Sowing
- Sprouting
- Fertiliser
- Earthing up.
- Pest, Disease and Weed Control.
- Harvesting
- Yield.

POTATOES



INTRODUCTION TO POTATOES

- Potatoes (*Solanum tuberosum*) are a member of the Order Solanaceae which includes tobacco and tomatoes.
- It is however classified as a root crop which is actually a misnomer as potatoes are actually swollen underground stems or tubers.
- Tubers are swollen underground stems, which plants use to store food and genetic information.

POTATO TUBERS



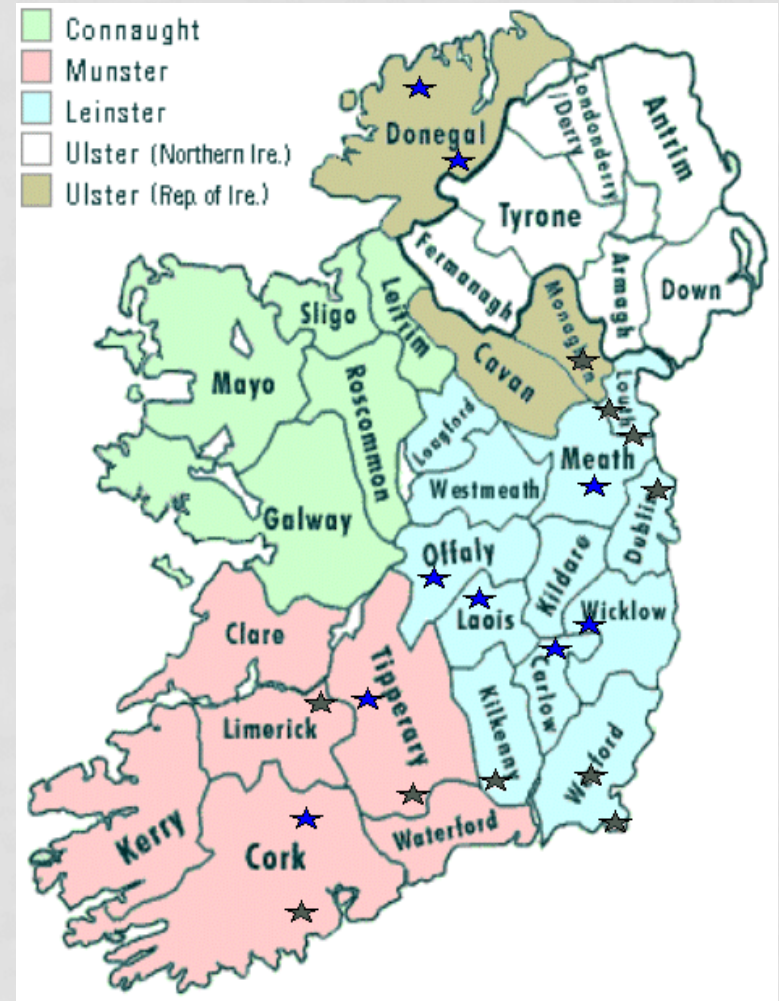
POTATOES

- Potatoes have long been part of the staple diet of the Irish.
- The Great Famine, caused by the failure of the potato crop due to blight in the 1845 which resulted in 1 million Irish people dying and another 1 million emigrating.



THE POTATO INDUSTRY

- There are over 800 potato farmers in Ireland with the industry valued at around €130 million.
- Most farms located in Dublin, Meath, Cork, Wexford & Donegal.
- Donegal farms are mainly for production of seed.




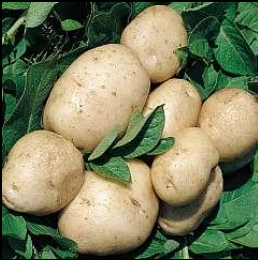



SOIL SUITABILITY

- The ideal soil is a deep well-drained, medium heavy loam with as few stones as possible.
- Those with high pH should be avoided and a pH of not lower than pH 5 should be used.
- The optimum pH should be about pH 5 or 5.5.
- South facing, gently sloping fields are best for first earlies.
- The soil must be frost free, so coastal areas are very suitable.
- However, main crop potatoes can be grown in most areas.

CHOICE OF VARIETY

There are three main harvest times for potatoes:

Home Guard	Kerr Pink	Rooster
 A cluster of small, round, yellowish-gold potatoes with a slightly rough skin, set against a black background.	 A pile of medium-sized, reddish-brown potatoes with a smooth skin. One potato is sliced in half, showing a bright yellow interior, and is placed on top of the pile. The background is a plaid pattern.	 A close-up view of several medium-sized, reddish-brown potatoes with a smooth skin, piled together.
Epicure	British Queens	Golden Wonder
 A cluster of small, round, light-colored potatoes with a smooth skin, set against a dark background.	 A cluster of medium-sized, light-colored potatoes with a smooth skin, growing on a green leafy plant.	 A close-up view of several medium-sized, light-colored potatoes with a smooth skin, piled together.

FIRST EARLIES

- First earlies (or “new potatoes”) can be planted as early as February and harvested from May onwards.
- Potatoes are harvested immature in early summer.
- Mainly grown in the frost-free coastal regions of this country.
- Low yield but High prices.
- E.g. Home Guard and Epicure are good varieties for first earlies.
- Home Guard has the best eating qualities, is early bulking and fairly high yielding, but it is susceptible to drought.



SECOND EARLIES

- Second earlies are also sown in February but are not harvested until mid Summer.
- Second earlies produce a higher yield but a lower price than first earlies.
- Produce heavier yields than first earlies and have better eating and keeping qualities.
- British queens are still the best and most popular variety: excellent eating quality and drought resistance but are very susceptible to blight.
- Others include: Dunbar Rover, Estima, Maris Piper and Wilja.

MAIN CROP

- The main crop is sown around April and harvested in September.
- These are late maturing, high yielding potatoes are harvested in Autumn at full maturity.
- The main crop can be stored if not used immediately.
- These are late maturing, high yielding and have better keeping qualities than first or second earlies.



MAIN CROP

- E.g. Kerr's Pink, Record, Roosters, Golden Wonder, Clada, Pentland Dell, Maris Piper, Cara.
- Golden Wonders: lower yielding but have higher dry matter content. Useful in Spring, slow to sprout.
- Rooster: red skinned; used for boiling steaming etc.



FACTORS TO CONSIDER WHEN CHOOSING A VARIETY

- The farmer needs to consider the following when choosing his variety
 - Consumer's choice (Saleability)
 - Yield
 - Eating quality
 - Maturity
 - Keeping quality
 - Disease resistance
 - Seed availability

CHOOSING VARIETY

- Potatoes can be described as “floury” or “soapy”.
- Firm moist potatoes or “Soapy” potatoes are moist and are popular in mainland Europe whereas “Floury” potatoes are dryer and fluffy and are well suited to the Irish market.
- Three popular varieties in Ireland are the Record, Kerr’s Pink and Golden Wonders.

PREPARATION OF SEEDBED - 1

- Autumn plough if possible.
- In spring, deep plough the soil to a depth of **22-25** cm.



PREPARATION OF SEEDBED - 2

- Soil can then be cultivated by a heavy duty cultivator such as a Power driven rotavator or power harrow.
- A One run harrow: (disc harrow, ridge harrow, soil crumbler) can then be used to produce a deep fine seedbed without compaction.



PREPARATION OF SEEDBED - 3

- All stones should then be removed.
- Stones can bruise potatoes (allowing infection) during harvesting and must be removed.
- Stones can be removed by hand or a machine called a de-stoner.



PREPARATION OF SEEDBED - 4

- The soil is then cultivated into ridges, using a specialised machine.
- A ridge is a raised area of soil into which the seed is sown.
- Ridges should be between 75 – 90 cm wide and 15cm deep.
- Wide ridges lesson potatoes “greening”, lesson compaction and give greater yields.
- Ridges prevent the seed from water logging.



SOWING THE SEED- 1

Seeds are sown using a potato planter (a specialised seed drill).



SOWING THE SEED- 2

- Seeds are sown into the ridges at a depth of 10 cm below surface- 76cm apart (watch weather as they are not frost resistance).
- The spacing of the seed in the ridges is governed by the size of the seed. As seed size increases the number of eyes / auxiliary buds (which develop and grow into individual plants) per tuber increases.
- This protects the seed from excess sunlight (which can cause greening, producing poisonous chemicals called alkaloids)

SOWING THE SEED- 3

- Seeds are available in 2 sizes: 35 – 45mm and 45 – 55mm.
- Seeds should be sown at uniform spacing

Number of seeds per hectare	Size of seed (mm)	Spacing (cm)
60,000	35 – 45	20 – 25
40,000	45 - 55	30 - 35

SOWING THE SEED- 3

- Typically 2.5 tonnes of seed are required per hectare.
- Certified seed which is free from viruses should be used.
- Seed should be sprouted before sowing as it speeds up growth, plant emergence and yields.



SPROUTING POTATOES

- Seeds are placed in shallow sprouting boxes.
- These boxes are placed in greenhouses.
- Temperature of 5.5°C minimum.
- Can increase yield by more than 5 tonnes.
- Sprouting is essential for first earlies.



SPROUTING POTATOES

- The ideal sprout length is 2.5 cm.
- An eye or chit emerges during sprouting.
- Each eye has the potential to grow into an individual plant.
- Large tubers produce more chits.



USING PLASTIC

- The use of plastic is common for early potatoes.
- The advantages of using plastic are that they can be harvested 10-14 days earlier and it can result in a higher yield: 1-2 tonnes.



NUTRITION: FERTILIZER REQUIREMENTS - 1

- Soil should be tested before applying fertilizer to determine what is requirement and how much (Johnstown Castle, Co Wexford).
- Typical Application Rates:
 - Nitrogen: 125 – 150 kg / ha
 - Phosphorous: 125 – 150 kg / ha
 - Potassium: 250 – 300 kg / ha
 - (Hint 150kg;150kg;300kg or 1;1;2)



NUTRITION: FERTILIZER REQUIREMENTS - 1

- 10:10:20
or
7:6:17
or
Sulphate of Potash
are ideal for potatoes
- Fertilizer should be applied
prior to sowing.



FERTILIZER REQUIREMENTS - 2

- Fertilizer application must be balanced.
- Fertilizers without chlorine should be used as this allows for greater dry matter content.
- Nitrogen increases yields but decreases dry matter (i.e. produces a wetter potato).



FERTILIZER REQUIREMENTS - 2

- Avoid excess nitrogen as it gives higher yield but lowers eating quality and can lead to can lead to blight susceptibility.
- Phosphorous increases blight resistance and increases dry matter.
- Potassium increases tuber size (i.e. yield) but excess potassium decreases dry matter content and eating quality.



PLACE IN ROTATION - 1

- Potatoes benefit enormously from crop rotation as it helps to prevent disease and pest build up in soils.
- A one in four rotation (i.e. Sown no more than once every three years).
- Intensive enterprises or seed growers should use a one in five rotation ie sowing potatoes one year in every five.
- Potatoes grow best as the first tillage crop after a “ley” where they benefit from the rich supply of humus: this will lead to higher yields and better skin finish.
- By law, all potatoes must be grown on soil free of eel worms, a persistent parasitic nematode.

PLACE IN ROTATION - 2

- If grown too often in a field they become affected by the potato cyst nematode (Potato Eelworm).
- This is a soil borne nematode or eelworm; microscopic in size which affects the crop's root system.
- Some potato varieties are resistant to eelworm attack and nematicides are available for soil use; the most effective control is rotation.

PLACE IN ROTATION - 3

- Potatoes can only legally be sold for seed from fields, which are eelworm free.
- Potatoes grow satisfactorily at any point in a rotation of crops.
- Where farmyard manure is available it is often applied to potatoes as it benefits from the increased organic matter levels.
- Potatoes help keep weeds under control.
- Wireworms may be a problem and will have to be controlled chemically.
- As part of a rotation, potatoes constitute the root break.
- Lime may be applied the year following.

PRODUCING CERTIFIED SEED POTATOES

Location

- The majority of potato seed is produced in Co. Donegal because
- The climate is cool and windy, and so it well suited to their growth.
- Cool windy conditions as well as a coastal area keep aphid populations low.
- Aphids transmit a number of serious diseases in potatoes.

CERTIFIED SEED

Certified Seeds are produced in accordance with certain procedures

- 1. Selection**
- 2. Initial Propagation**
- 3. Further Propagation**

1. SELECTION

- Potatoes to be used as seed must come from fields that are completely free from Potato Root Nematode and must be also free of this infestation.
- They are also strictly tested for the three principal diseases of potatoes.
- The three most important are virus y, leaf roll and leaf mosaic diseases and these seeds must come from fields free of Potato root nematode.
- The seed is selected from farms in Donegal that are endorsed by the Department of Agriculture and Food.

2. INITIAL PROPAGATION

The selected potatoes are propagated using two different methods.

- They are grown under strict growing conditions in high elevation windy “nucleus plots” in Donegal or else using micro propagation techniques in the lab.
- These plots are strictly controlled and are isolated from one another.
- The growing vegetation is regularly tested for viral infection.

3. FURTHER PROPAGATION

- Once enough seed is available it is distributed to selected growers nationwide and propagated further in isolated, supervised conditions.
- They are continuously tested for viral and other diseases.
- Potatoes from this final propagation are sold as certified seed to farmers.
- These seeds are not true seeds, but immature asexual tubers (clones of parent plant).
- The quality of the new plants will be identical to parent.
- Seed is grown in a 1 in 5 rotation system.

ADVANTAGES OF USING CERTIFIED SEED

- Seed has a high % germination
- Crop has a better rate of establishment
- Seed has a higher yield
- Fewer weeds
- Seed is true to type
- Fewer pests and diseases
- Easier to market the crop

DISADVANTAGES OF CERTIFIED SEED

- This seed is however quite expensive as it involves a lot of time and high costs.
- Most growers buy certified seed every two or three years and use it to produce home grown seed.
- This can be achieved by planting the seed in an isolated part of the farm and spraying with pesticides.
- The vegetation is then killed off early which ensures the maximum number of potatoes in the seed size range.

ESTABLISHMENT

- Potatoes are planted in open ridges or drills
- They are earthed up or moulded and harrowed down at intervals.
- Earthing up is carried out when the crop is 20-25cm high.
- A ridger is used to deepen the furrows and widen the ridges.

ESTABLISHMENT

- Earthing up prevents greening: cause by exposure to sunlight and formation of alkaloids, which are poisonous.
- It is against the law to sell greened tubers.
- Harrowing: kills all germinating annual seeds. This helps keep air in at the roots of the plants.
- When potato haulms meet across the drill, the weeds will be controlled.

DISEASES, PESTS & WEED CONTROL



DISEASES OF POTATOES

Disease	Symptoms	Control
Leaf roll Virus transmitted by aphids	Rolled leaves, & stunted growth	Controlled using certified seed & aphicides
Leaf mosaics Virus transmitted by aphids	Mottled leaves, stunted growth	Use certified seed
Blackleg Bacterium (<i>Erwinia carotovora</i>)	Blackening of lower parts of stems. Blackening of the stored tubers.	Use certified seed. Avoid poorly drained fields. Avoid putting wet tubers in stores.
Gangrene Soil borne fungus (<i>Phoma exigua</i>)	Dark coloured depressions on stored tubers. Secondary infections by bacteria.	Use certified seed. Avoid damage at harvest. Apply chemicals if necessary
Common scab Soil borne bacterium (<i>Streptomyces</i> scabies)	Dark superficial scabs on tubers which affect selling quality.	Use certified seed. Avoid high pH soils. Do not lime potato crop or previous crop.

DISEASES OF POTATOES

Disease	Cause	Symptoms	Control
Leaf Roll	Viral disease (aphids)	Rolled leaves Stunted growth	Use certified seed
Leaf Mosaics	Viral disease (aphids)	Mottled leaves (speckled) Stunted growth	Use certified seed
Blackleg	Bacterial disease	Lower stem becomes black Stored tubers become black	Use certified seed Avoid badly drained fields Avoid storing wet tubers

DISEASES OF POTATOES

Disease	Cause	Symptoms	Control
Gangrene	Fungal disease	Deep dark coloured areas on tubers	<ul style="list-style-type: none">• Use certified seed• Spray with a systemic fungicide
Common Scab	Bacterial disease	Dark scars on tubers (affect selling quality)	<ul style="list-style-type: none">• Use certified seed• Avoid high ph (basic) soils• Do not apply lime

DISEASES OF POTATOES INCLUDE

- Potato blight – a fungal disease which can affect plants in humid weather.
- Blackleg – a bacterial disease which thrives in wet conditions.
- Gangrene – fungal.
- Common scab – bacterial disease which thrives in soils with high pH (**Avoid Lime**)
- Potato mosaic – viral disease spread by aphids.

PREVENTING DISEASES

Diseases are prevented by spraying fungicides every 7 – 10 days.

There are different types of fungicides:

Systemic: goes to all parts of the plant and is best when the growth is rapid.

Contact: only protects what it touches.

Translaminar: spreads all over leaf and protects it.

Spraying insecticides kills aphids and prevents viral diseases.

POTATO BLIGHT - 1

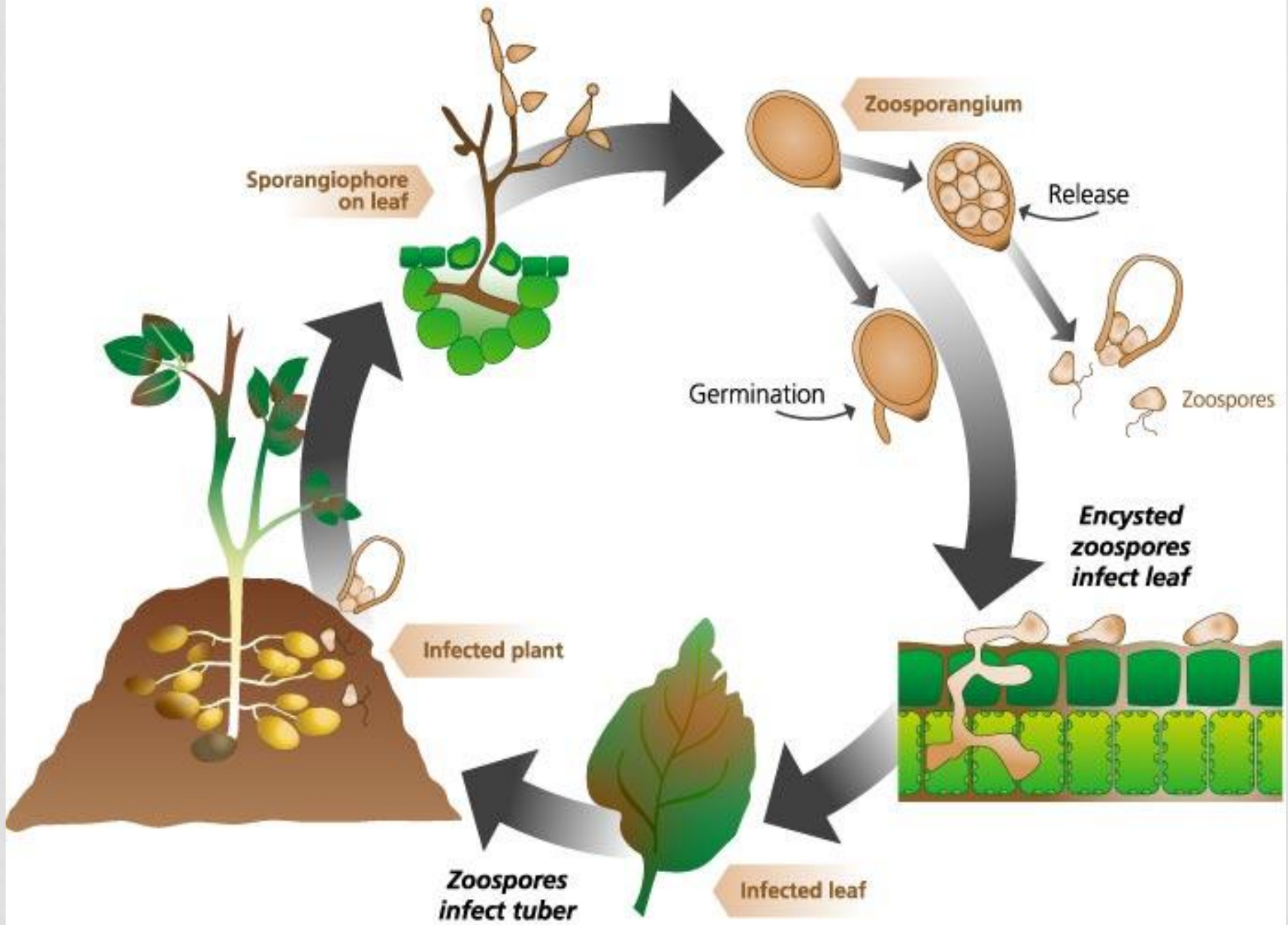
- Potato Blight or *Phytophthora infestans* is a fungal disease.
- The symptoms of blight include a browning and subsequent blackening of the leaves and rotting of the tubers.
- Tiny branches of hyphae, called haustoria, penetrate cell walls and break down and absorb plant tissue.
- These haustoria can form sporangia which produce zoospores, which can spread from plant to plant.



POTATO BLIGHT - 2

- It causes premature death of haulms with resultant yield losses.
- In the case of bad infections, blight spores may be washed by rainfall from the haulms onto the soil and onto the tubers.
- This leads to infection and rotting during storage.
- The spread of potato blight is favoured by warm humid weather conditions.





PREVENTING BLIGHT

- Do not sow seeds showing any signs of blight.
- Earthing up creates greater distance from zoospore and tuber.
- Remove all tubers at harvest (known as volunteer potatoes).
- Spray with contact or systemic fungicide throughout the growing season, every 10 – 14 days (and in response to blight warnings issued on radio and television).
- Crops should be sprayed prior to infestation with a suitable fungicide every 10 days until September 1st.
- Remove haulms before harvesting.



PEST CONTROL



- The main pests of potatoes are:
- Wireworms – can eat into tubers, common after grass, prevented using poison baits.
- Slugs – eat into tubers, high numbers during wet summers, killed using slug pellets
- Aphids – eat plant and carry viral diseases, controlled using insecticides or ladybirds
- Potato cyst nematode and eelworms – eat into tubers, controlled by crop rotation.



PESTS

Pest	Symptoms	Control
Wireworms	They are most likely to be numerous in the first two years after a ley. Some species also attack barley. They attack the tubers, eating into them and lowering tuber quality.	Insecticides (Aldrin) is worked into the soil before planting, gives good control.
Aphids	Suck the sap of the growing plants, responsible for the spreading of disease.	Where numbers are more than 3 per plant use Aphicides or insecticides
Slugs	Can be troublesome, especially after a wet summer and where the soil is rich in organic matter.	Slug pellets should be broadcast over the soil.
Eelworm	Affects the crops root system	Nematicides or Aldicarp granules can be used is moderate to fairly high. They will give an economic yield response but not eradicate the pest. A good rotation is the only reliable method of control.

WEED CONTROL

- Crops are sprayed with a contact herbicide when one quarter of plants have appeared over the soil.
- A contact (residual) herbicide kills all plant tissue it comes in contact with.
- The rest of the plant recovers.
- This allows for weeds to be controlled until “shading” occurs, which naturally prevents weeds.
- Shading refers to the time when plants meet across ridges.
- Earthing up also prevents weeds.



EARTHING UP

- Earthing up is an important post sowing cultivation of the potato crop.
- When the plant is 15 – 20cm high, a ridger is used to bank up more soil around the stem.



EARTHING UP

- Earthing up is important because:
 - It keeps the soil loose.
 - Prevents greening of potatoes.
 - Stops annual weeds from germinating.
 - Can help to prevent disease (blight).
 - Can help to increase yield



HARVESTING - 1

- Early potatoes are harvested from May/Early June on depending on variety and part of the country.
- Main crop potatoes are harvested in late September or October where tubers are fully-grown and mature.

HARVESTING - 2

Potatoes are harvested in a number of stages.

Stage 1: **Burn Off**

- Three weeks before harvesting a desiccant (a contact herbicide) is applied; which kills the haulms.
- The Burning off of the Haulms prevents blight and makes it easier for harvesting machinery pass through the land and prevents blight spores from being washed into the soil and tubers.

Stage 2: **Maturation** –

- In the three weeks before harvesting, the skins of the tubers toughen and harden, which prevent bruising or scratching during harvesting

HARVESTING - 3

Stage 3: **Lifting** –

- An elevator digger or potato harvester lifts the tubers out of the soil.

Stage 4: **Storage** –

- Earlies are used immediately, but the main crop is stored in a cool, dark, well ventilated building. Can be sprayed with inhibitor to prevent sprouting. Can be covered in straw.



USING AN ELEVATOR DIGGER/POTATO HARVESTER

- The **Elevator digger** lifts potatoes from the soil and removes any soil/stones. The Potatoes are then returned to the soil where they are hand picked
- The **Complete Potato Harvester** works the same as the elevator digger except the potatoes are placed in a storage bin and don't have to be hand picked



YIELDS

Typical yields are as follows:

- First earlies: 7 – 10 tonnes per hectare
- Second earlies: 12 – 15 tonnes per hectare
- Main crop: 30 – 40 tonnes per hectare

- An average potato in the main crop weighs 75g with DM of 18 – 21% best
- A potato plant produces 12 tubers on average.
- Yields depend on sunshine – highest yields are obtained in the south east.

STORAGE

Buildings which store the potatoes must be

- leak proof
- frost proof
- Potatoes are also covered with a layer of straw to protect against frost; as wetting and frost encourage rotting
- well ventilated to prevent sprouting and rotting.
- large enough to allow easy access of tractors and trailers.
- made from reinforced concrete to support many tonnes of potatoes.
- ~ 4-6 °C in temperature
- If the potatoes are being stored after the 1st of February they need to be treated with a sprout inhibitor or kept in a refrigerated area.

FOOD VALUE AND FINAL USE

- Potatoes are a versatile, carbohydrate rich food highly popular worldwide and prepared and served in a variety of ways.
- The potato is a moderate source of iron, and it has a high vitamin C (a single medium sized potato of 150 g provides nearly half the daily adult requirement)
- It is a good source of vitamins B1, B3 and B6 and minerals such as potassium, phosphorus and magnesium.

FOOD VALUE AND FINAL USE

- Potato is low in fat – but preparing and serving potatoes with high fat ingredients raises the caloric value of the dish.
- Boiling potatoes in their skins prevents loss of nutrients.
- Potatoes are important in many diets, but need to be balanced with other vegetables and whole grain foods and meats.