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MINISTRY FOR AGRICULTURE,
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POTATO PRODUCTION INTEGRATED PEST MANAGEMENT GUIDELINES

Agriculture Directorate

Agriculture Research & Innovation Hub

AgriConnect

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PLANT PROTECTION PRODUCT AUTHORISATION

Plant protection products (PPPs) need to be authorised by the MCCAA to be placed on the Maltese market in accordance with the provisions of Regulation (EC) No. 1107/2009 implemented in Malta through Legal Notice 284 of 2011, Plant Protection Products (Implementation) Regulations, issued under the Pesticides Control Act (Cap. 430).

A list of authorised PPPs can be found on the MCCAA website:
https://mccaa.org.mt/Section/Content?contentId=1158

It is the legal obligation of all farmers and professionals making use of PPPs to consult the list prior to the purchase or application of any products to ensure their authorisation, even if they are listed in this publication. If assistance is required, one can contact AgriConnect for further assistance.

For PPP substances which are listed in this publication and are currently not authorised, the Agricultural Directorate encourages farmers, farmer representatives and commercial entities to contact AgriConnect, which will provide information and assistance in the authorisation process of products containing such substances.

Colour code for substances listed in this guideline:

- Authorised for use in the Maltese Islands.
- Can be authorised for use.
- Organic.

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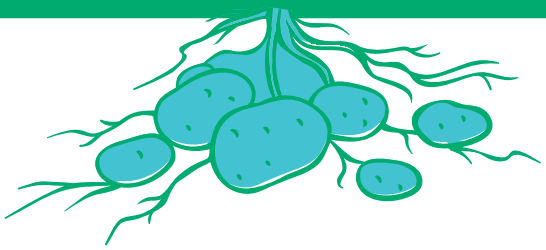

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Aphids

Myzus persicae, Macrosiphum euphorbiae

The two most common aphids on potatoes are the green peach aphid (*Myzus persicae*) and the potato aphid (*Macrosiphum euphorbiae*). Aphids are sap-sucking insects and can also cause damage by being vectors for disease, spreading viral pathogens. The green peach aphid adult is oval-bodied, around 1.2–2.1mm in length, and yellow-green to grey-green. The potato aphid is relatively large in size and has an elongated pear-shaped body. The colour varies from yellow-green to pinkish red. Adult females can be wingless or winged and their body size is around 1.7–3.6mm long. One often finds aphids at different life stages on one plant. Aphids can attain high density, and severe infestations may lead to weakened plants caused by abundant feeding.

Management and Control

Chemical interventions

Only intervene in the presence of widespread infestation.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Acetamiprid (1)
- Azadirachtin
- Pyrethrin
- Sulfoxaflor
- Maltodextrin

LIMITATIONS OF USE & SPECIAL CONDITIONS

(1) At most, apply one intervention per year using Neonicotinoid-type products.

Macrosiphum euphorbiae aphids [1]

Myzus persicae infestation [2]

Cutworms

Agrotis spp.

Various species of cutworms can affect potato plants.The larvae (caterpillars) in their early stages can cause 'shotholes' while feeding on tender leaves of young plants. As the caterpillars mature, they become most active at night, and during the day are present in the soil. Damage is caused when there is a widespread infestation, with the cutworms feeding and cutting off the stem of the potato plant, in which case seedlings could be damaged, with the cutworm severing the main stem of the plant.

Management and Control

Chemical interventions

Intervene upon detection of widespread infestation of the first generation young larvae.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Cypermethrin (3)
- Beauveria bassiana
- Spinosad (1)
- Tefluthrin (2)
- Lambda-cyhalothrin (2)

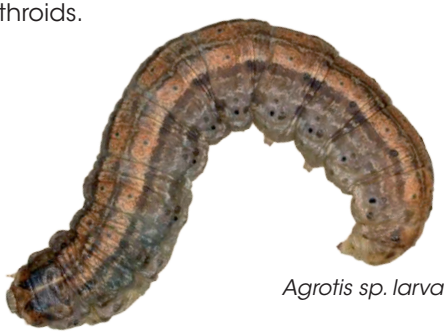
LIMITATIONS OF USE & SPECIAL CONDITIONS

(1) Do not exceed three applications per growing season from all spinosine-type compounds.

(2) To be used when sowing or when soil is piled around the tuber seeds.

(3) To be used on sowing. Geo-disinfectant-type treatments do not fall within the limitations on the use of Pyrethroids.

Agrotis ipsilon next to severed stem [3]



Agrotis sp. larva [4]

Potato Tuber Moth

Phthorimaea operculella

The potato tuber moth is oligophagous and feeds on various crops in the plant family *Solanaceae,* significantly impacting the potato crops. The larvae feed on various vegetative parts of the crop. The leaves are damaged through larvae feeding on the mesophyll within the leaves without damaging the upper or lower epidermis. The most significant damage is caused when the insect feeds on the tuber. The adult moths lay eggs through cracks in the soil on the developing tuber. Larvae feeding results in irregular galleries that run inside the potato tuber. Detection is somewhat difficult unless the potato tubers are dissected. The adult moth is generally just under 1cm in length with a pale brownish-grey colour. The first adults appear in spring, when the temperature is about 10 to 13 degrees Celsius and lay down their eggs normally near the potato tuber eye (axillary bud).

Management and Control

Agronomic interventions

- Sow healthy seed potatoes

Upon detection of pest, intervene by taking the following actions:

- Use early varieties with deep suberification.
- It is advisable to carry out early sowing.
- Pile soil around the base of the plant at frequent intervals.
- Harvest as early as possible.
- Destroy crop residues immediately after harvesting.
- Transport the tubers quickly to the storage rooms after harvest.
- Keep the warehouse temperature below 10°C.

Chemical interventions

Intervene upon detection of pest.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Spinosad (2)
- Cypermethrin (1)
- Deltamethrin (1)
- Lambda-cyhalothrin (1)
- Etofenprox (1)
- Chlorantraniliprole (3)
- Emamectin benzoate (3)

LIMITATIONS OF USE & SPECIAL CONDITIONS

(1) It is allowed to intervene with a maximum of three applications in instances where infestations with Potato tuber moth were detected in previous growing seasons. Do not exceed more than three interventions per growing season with active substances of the same mode of action (IRAC 3); Deltamethrin, Cypermethrin, Etofenprox, Lambda-cyhalothrin and Tefluthrin.

(2) Do not exceed more than three applications per growing season from all spinosine-type compounds.

(3) Maximum of two interventions per growing season regardless of adversity of the crop.

Phthorimaea operculella larva [6]

Larva feeding on leaf [7]

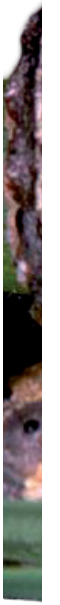
Phthorimaea operculella adult moth [5]

Damage to tuber by larvae [6]

Corn Earworm, Armyworms

Helicoverpa armigera, Spodoptera spp.

The corn earworm, also known as the cotton bollworm *(Helicoverpa armigera)*, and armyworms (*Spodoptera* spp.), are common pests of a variety of important crops, and refer to the larval stage of specific moths. The caterpillar larvae cause damage to potato plants by feeding on leaves, leaving a lace-like pattern. Severe infestations can cause the larvae to devour entire leaves. Female moths can lay hundreds of eggs. Fully grown caterpillar larvae are approximately 4cm long. The larvae can have different colour forms depending on the species and the different growth stages. Commonly the species of larvae caterpillars are whitish-yellow, green, and brown to mottled reddish-brown.



Management and Control

It is recommended to apply traps impregnated with a specific sex pheromone to monitor the infestation. Deploy one per plot and species.

Upon detection of the first captures, it is recommended to intensify monitoring on the crop.

Chemical interventions

Intervene upon detection of the first generation of eggs or larvae.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Etofenprox (1)
- Lambda-cyhalothrin (1)

LIMITATIONS OF USE & SPECIAL CONDITIONS

(1) Apply a maximum of two interventions per year between Pyrethroids and Etofenprox, regardless of adversity.

Damage on leaves [10]

Spodoptera sp. larva [9]

Helicoverpa armigera larva [8]

Wireworms

Agriotes spp.

Wireworm is the common name given to the larval stage of different species of beetles from the *Agriotes* genus. Mature female beetles lay their eggs in the soil. When the larvae have just hatched they are white, and as they mature the larvae generally become yellow-brown. They remain present in the soil. The larvae develop a tough skin and can grow up to 3cm in length. In the larval stage, the pest causes damage to the potato tuber due to larval feeding. Larvae burrow tunnels in the tuber, and the tubers can exhibit multiple entry and exit holes.

Management and Control

Avoid late irrigation near the harvest to limit the increase in pest abundance.

Take action when the presence of larvae has been ascertained or based on the frequency of infestations detected in the previous year.

PLANT PROTECTION SUBSTANCES AND DEVICES

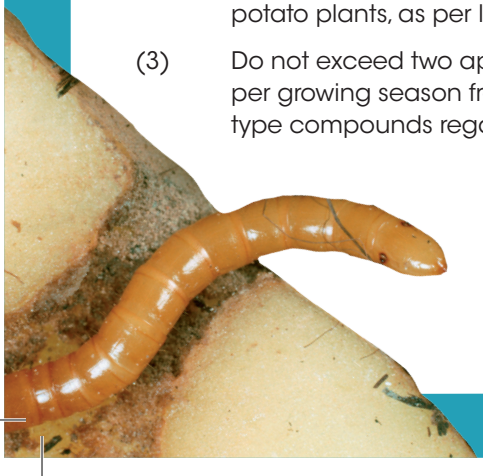
- Cypermethrin (3)
- Lambda-cyhalothrin (2) (3)
- Deltamethrin (3)
- Etofenprox (3)
- Spinosad (1)
- Beauveria bassiana

LIMITATIONS OF USE & SPECIAL CONDITIONS

(1) Do not exceed more than three applications per growing season from all spinosine-type compounds.

(2) To be applied within the ridge of the potato plants, as per label instructions.

(3) Do not exceed two applications per growing season from all pyrethroid-type compounds regardless of adversity.



Wireworm eating on tuber [11]

Feeding damage on tuber cross section [11]

Black Scurf, Stem Canker

Rhizoctonia solani

Black scurf or stem cranker is caused by a pathogenic fungus that is seed- or soil-borne and is transmitted through sclerotia or mycelium present in infected tubers, plant residue or soils, where it can survive 6–7 years. The disease affects the plant at every stage of its development. In the stem, it can cause the tissue to brown and rot. In the tubers, the disease manifests as black scurf in the form of dark, hard, crust-like structures that form on the skin. The crop stand of infected seedlings is low. Infected stolons may not mature well, resulting in overall yield reduction. Stunting or rosetting of plant tops may also occur.

Management and Control

Agronomic interventions

- Use healthy seed potatoes.
- Carry out crop rotation extensively and include the cultivation of cereal/fodder crops in the crop rotation (4–5 years).
- Use pre-sprouting and shallow sowing to accelerate growth phase.
- Eliminate and destroy infected plants.
- Soil solarization.
- Increase the soil organic matter.

Black scurf on tubers [12]

Stem Canker [12]

PLANT PROTECTION SUBSTANCES AND DEVICES

- *Pseudomonas sp.* strain DSMZ 13134
- *Bacillus subtilis* strain QST 713
- Flutolanil (1)
- Azoxystrobin (2)
- Tolclofos-methyl (3)
- Fluxapyroxad (4)

LIMITATIONS OF USE & SPECIAL CONDITIONS

(1) Use only once per growing period regardless of adversity or crop.

(2) Do not exceed more than two applications per growing period regardless of crop or disease whilst keeping to the limit of not more than three applications from compounds: Azoxystrobin, Pyraclostrobin and Fenamidone. When applied at sowing within the farrow it is also important not to exceed one application every two years.

(3) Compound is to be applied directly at pre-sowing phase on the tuber itself.

(4) Use not more than two times between active substances Fluopyram and Fluxapyroxad.

Phytophthora blight

Phytophthora infestans

Phytophthora blight, also known as potato blight or late blight, is an infection caused by a water mould (also known as oomycete), which is a fungal-like microorganism. Phytophthora blight negatively impacts both potatoes and tomatoes. In potato crops, the pathogen can devastate a harvest, reducing yields and producing shrunken tubers. The flesh underneath the skin of the tuber would be corky, granular and exhibiting dry and wet rot. The symptoms on the leaves will first appear as a small pale to dark green water-soaked spots which have an irregular shape and surrounded by a zone of yellow tissue. Symptoms of the disease may also be visible on the underside of leaves in the form of lesions (2–10mm) that turn brown and become necrotic. When there is the ideal conditions for this decease the lesions/injury will grow faster and change to brown to purplish black as the tissue is killed. WWhen there are sufficient humidity levels one can observe white sporulation of the fungus, normally on the underside of the leaves. The symptoms on the stem and petioles will appear in lesions of brown to black. Before sowing, seed tubers can be inspected since lesions may indicate an infection.

The ideal climate conditions for blight to occur are when there is a constant temperature between 10 and 24 degrees Celsius and humidity over 75% for at least 48 hours or 90% for 10 hours for 8 days. In these conditions it is likely that an outbreak will happen within 2 to 3 weeks. If, in addition to these, within this period there are several hours of rainfall, dew and/or high humidity levels, these conditions will further increase the likelihood of an outbreak.

Management and Control

Agronomic interventions

- Select varieties that are less prone to infection.
- Always use potato seeds that have been verified against the presence of pathogens.
- Remove and eliminate any leftover plant residues in the soil from previous harvests.
- Carry out crop rotation extensively.
- Carry out balanced fertilisation, as crops with an excess amount of nitrogen tend to be more predisposed to this pathogen.
- Leave an appropriate sowing distance to avoid an excessive density of plants. It is recommended to sow potatoes 20-30cm between seeds within the row, with a row width of 60-80cm, circa 6-7 plants per square metre.

Phytophthora infestans on potato leaves [14]

Chemical interventions

Act upon the occurrence of conditions predisposing the infection.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Cyazofamide (2)
- Cymoxanil (2)
- Foseytl-Aluminium
- Fluopicolide (7) + Propamocarb
- Zoxamide (6)

- Cupric products (1)
- Valifenalate (formerly Valiphenal)
- Metalaxyl-M (2)
- Metiram (3)
- Mandipropamid (4)
- Pyraclostrobin (5)
- Propamocarb
- Amisulbrom (2)
- Oxathiapiprolin (2)
- Fluopicolide (9)
- Ametoctradin (8)
- Dimethomorph (4)

Rot of potato tuber [13]

LIMITATIONS OF USE & SPECIAL CONDITIONS

The cupric products also act on alternariosis. With the exception of cupric products, a maximum of four interventions per year are recommended against this adversity.

(1) Limit of 28 kg / ha in 7 years. It is recommended not to exceed the average quantity of 4 kg / ha of copper per year on the crop.

(2) Do not exceed three interventions per growing period regardless of crop or disease.

(3) Do not exceed two interventions per year. When using Dithiocarbamates, take care to apply the product not later than 21 days prior to harvest.

(4) Do not exceed four interventions per year with all CAA (Carboxylic Acid Amides) type products.

(5) Use not more than twice per year from compounds Azoxystrobin, Fenamidone and Pyraclostrobin per growing period regardless of crop or disease.

(6) Do not exceed four interventions per growing period regardless of crop or disease.

(7) Not more than one intervention per growing period regardless of crop or disease.

(8) Do not exceed two interventions per year.

Early Blight

Alternaria porri f. sp. solani

Early blight is caused by a fungal pathogen that can affect leaves, stems and potato tubers, reducing overall yield and quality. Symptoms appear on leaves as dark brown/black lesions that can be circular or irregular on the older (lower-lying) leaves. The lesions have a 'target spot' appearance due to the alternating concentric rings ranging from light tan to dark brown tissue. As the disease progresses, multiple lesions may coalesce, and once infection becomes severe, leaves drop prematurely. Tubers that are infected exhibit a dry rot, characterised by dark sunken lesions on the surface that may be circular or irregular in shape. The tissue under the lesions is dark and firm. Prolonged foliar moisture and conditions close or beyond saturation point favour infection and symptom development. The ideal temperature would be about 16 to 30°c.

Management and Control

Agronomic interventions

- Keep the storage rooms for seed potatoes fresh and ventilated.
- Use healthy seed potatoes and avoid the use of sensitive varieties.
- Avoid injury to the seed potatoes.
- Destroy infected tubers and other residues from the previous crop.
- Carry out crop rotation extensively (4–5 years).
- Carry out balanced fertilisation, as crops with access amount of nitrogen tend to be more predisposed to this pathogen.

Chemical interventions

Only intervene in the case of infections on young plants, since the anti-mildew products are also effective against Alternaria disease.

PLANT PROTECTION SUBSTANCES AND DEVICES

- Difenoconazole (2)
- Cupric products (1)

- Zoxamide (3)
- Pyraclostrobin (4)
- Azoxystrobin (4)
- Dimethomorph (3)

LIMITATIONS OF USE & SPECIAL CONDITIONS

(1) Limit to 28 kg / ha in 7 years. It is recommended not to exceed the average quantity of 4 kg / ha of copper per year on the crop.

(2) Do not exceed more than one application per growing period regardless of crop or disease.

(3) Not more than four applications per growing period regardless of crop or disease.

(4) Use not more than twice per growing season. Do not exceed limit of three applications from compounds: Azoxystrobin, Pyraclostrobin and Fenamidone.

A potato leaflet showing early blight symptoms [15]

External and internal view of early blight lesions [16]

Black Dot

Colletotrichum coccodes

Colletotrichum coccodes is a fungal pathogen that affects all underground parts of the potato plant, including roots, tuber and stolon, but can also infect other plant tissues, such as stems. The fungal disease can be identified through the presence of sclerotia that look like fine black blemishes on the skin of the tuber. The disease reduces the quality of the skin of potato tubers. The pathogen is soil-borne and can be infectious for more than 2 years.

Management and Control

Agronomic interventions

- Use healthy seed to aid the development of the plant in the early stages of growth.
- Avoid water stagnation and limit irrigation.
- Eliminate infected vegetation, which must not be buried.
- Carry out extensive crop rotations (4–5 years).

Black Dot symptoms on potato tuber [26]

Tiny Black Dot microsclerotia on potato stem [27]

Fusarium Dry Rot

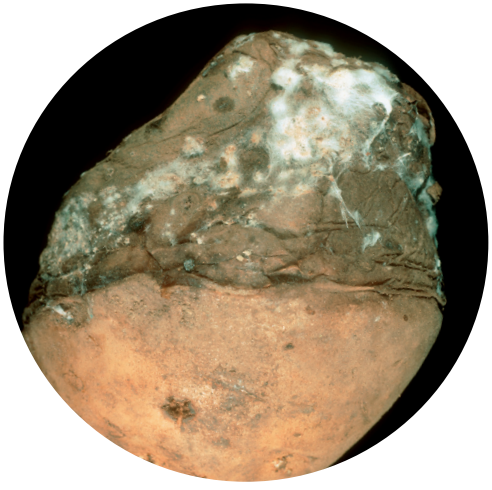
Fusarium solani

Fusarium solani is a fungal pathogen that causes dry rot in tubers. The infection starts at a wound site where the tuber is bruised or cut. The disease spreads into the tuber creating rot from the inside. Symptoms include sunken areas and wrinkling of the tuber. The internal infected area is light-brown to black, and internal cavities may have the presence of white, yellow or pink mould. This dry rot can cause damage to harvested potatoes in storage as well as seed tubers. Fusarium dry rot is both seed- and soil-borne. The optimum temperatures for the growth of this disease ranges from 15°C to 20°C and with relative humidity of 70%. In the case where potato tubers are stored in cold rooms, temperature above 10°C can increase the growth of Fusarium, while a temperature of 5°C or lower is known to reduce the chances of infection.

Management and Control

Agronomic interventions

- Before storing potatoes it is important to discard tubers which may have any wounds, pest and disease.
- Before storage, if the tuber is bruised it is advisable to cure the tubers at a temperature of 10°C to 18°C with relative humidity of 85% for two weeks.
- Keep the storage rooms for seed potatoes with proper circulation of cool air and good ventilation.
- Use healthy tubers/seeds.
- Avoid injury to the tubers during harvesting.
- Soil solarisation.



Dry rot Fusarium infection of a potato tuber [11]

Potato Gangrene

Phoma exigua

Phoma exigua is a fungal pathogen that causes gangrene or pit rot symptoms in potato tubers, resulting in significant loss especially during storage. Symptoms of the disease include dark sunken lesions, dry pits, and hollowing in the tuber. The depressions on the surface of the tuber enlarge to form irregular cavities. Small, black spheroidal bodies (pycnidia) may also be present. The pathogen is soil-borne or can remain present in seeds.

Management and Control

Agronomic interventions

- Limit injuries to the tuber.
- Destroy infected residues promptly.
- Place the freshly harvested seed potatoes in warm environments (18–20°C) for two weeks, in order to promote wound healing.
- Sow disease-free tubers.

Gangrene external symptoms on diseased potato tuber [11]

Erwinia Soft Rot

Erwinia spp.

Erwinia spp. are coliform bacteria associated with soft rot in potato tubers and blackleg (stem rot). Soft rot causes the tuber tissue at the site of infection to become water-soaked and macerated. Eventually, the rot spreads through the whole tuber, releasing a foul smell caused by the action of Erwinia spp. and secondary bacteria and pathogens. The infection may cause non-emergence of the plant, wilting, browning, desiccation, blackleg and plant death. The potato tuber seeds may have a latent infection and not exhibit any symptoms before sowing.

Management and Control

Agronomic interventions

- Carry out crop rotations extensively.
- Avoid causing injury to plants.
- Remove and destroy infected plants immediately.

Erwinia carotovora
soft rot in tuber [17]

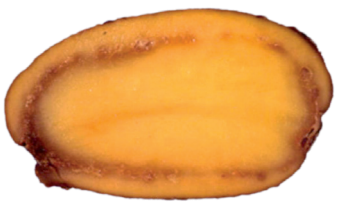
Bacterial Wilt

Ralstonia solanacearum

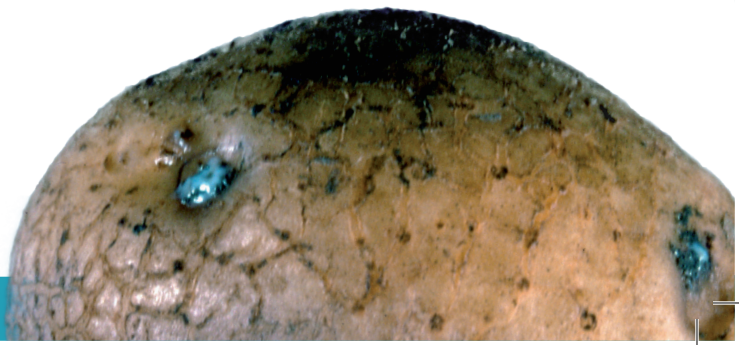
Bacterial wilt is a disease caused by pathogenic bacteria. Early signs of infection are visible on the foliage. Young leaves at the end of the branches wilt during hot parts of the day and recover at night. As the disease continues to develop, discolouration of the stem may be observed a few centimetres above the soil line. The leaves start to progressively wilt and a bronze tint is developed. This subsequently leads to complete wilting without recovery, and plant death. External symptoms on the tuber may not always be visible. In some cases, bacterial ooze emerges from the eyes and stem-ends of infected tubers. A cross-section of the infected tuber reveals a brown discolouration of the vascular ring and surrounding tissue. Milky-white fluid exudes from the freshly-cut section of the vascular ring, indicating infected tissue.

Management and Control

As per Subsidiary Legislation 433.07– Control of *Ralstonia solanacearum* (Smith) Yabuuchi et al, as amended by L.N. 42 of 2007, referring to the control against *Ralstonia solanacearum*, there is a **legal obligation to promptly report to the Phytosanitary Authority (Plant Protection Directorate) any potential presence of symptoms** of this disease on the seed potatoes, as well as on the crop in the field and on the tubers collected, in order to be able to carry out the appropriate investigations in the laboratory.

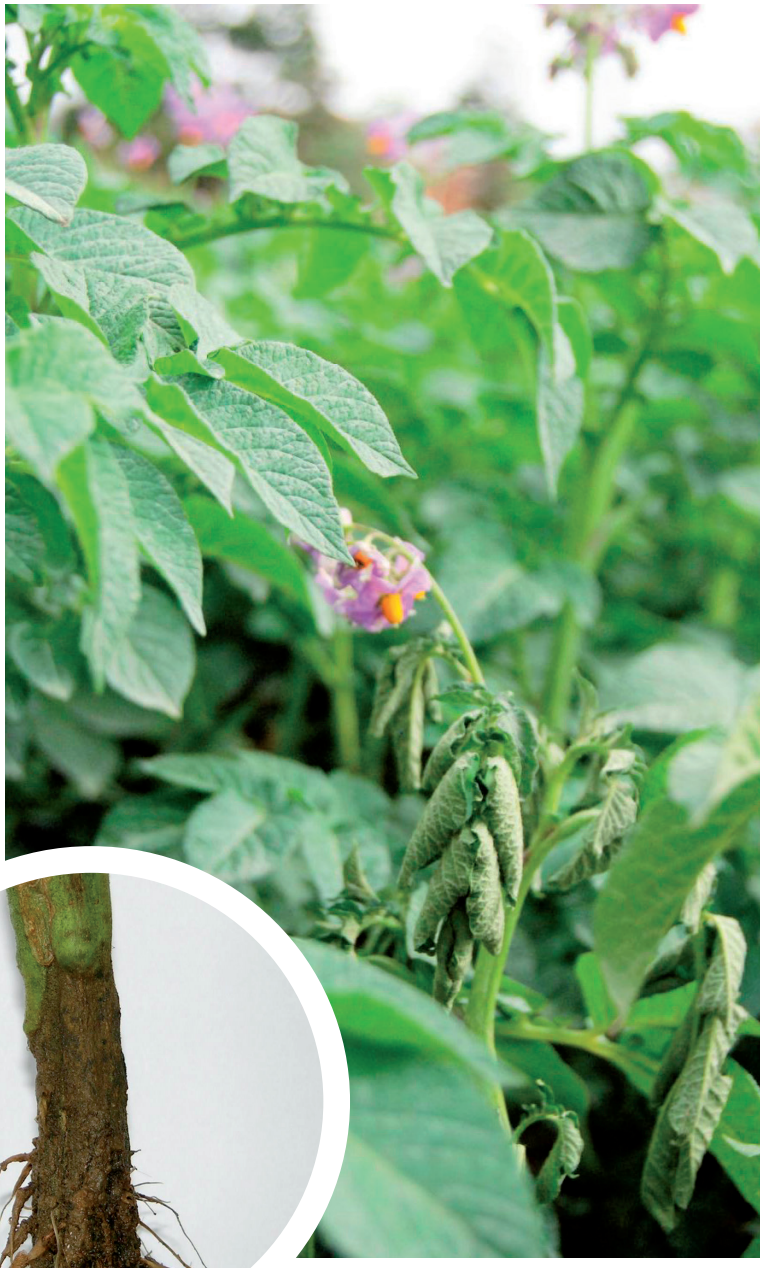


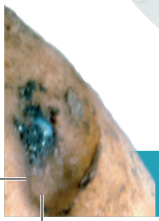
Symptoms of Bacterial Wilt on cut tuber [28]



Bacterial ooze exuding from eye of tuber [21]

Wilting of potato plant [18]





Discolouration of the stem [19]
Foliar symptoms of Bacterial wilt on potato plant [29]

Potato Viruses

PVX, PVY, PLRV

Various viral pathogens can affect potato plants, and these include potato virus X (*PVX*) potato virus Y (*PVY*), and potato leafroll virus (*PLRV*). Transmission of virtual pathogens occurs through pest vector such as aphids and other insects, as well as mechanically. The disease can occur as a primary infection, i.e. the plant would have been infected through a vector, or as a secondary infection, i.e. the seed would have been infected, and this results in a completely infected plant. Viral disease may lead to production losses of 50% or more. Symptoms of the viruses vary, especially since a plant may be infected with multiple viral pathogens and strains. PLRV symptoms include rolling of the leaves, leathering, stunted growth and chlorotic appearance. PVY and PVX can result in various symptoms depending on the potato variety. Symptoms can manifest as a reduction in leaf size, wrinkling, mosaic, and wilting that may lead to necrosis and leaf death. Chlorotic mosaic on the haulum may also be visible. Tubers may be smaller, and exhibit necrotic lesions and ring spots and growth cracking.

Management and Control

Agronomic interventions

- Use certified seed with low level of viral infection.
- Carry out crop rotations extensively.
- Remove and destroy infected plants immediately.
- Eliminate plants originating from residual tubers of previous crops.
- Carry out removal of weed plants.
- In low lying areas where conditions for virus spread are prevalent, it is essential that seed is replaced annually.
- Anticipate or delay sowing to coincide with crop cycle to ensure that crop growth occurs when there is minimum presence of vector aphids.

Potato leaf roll virus symptoms [22]

Discolouration and chlorosis [23]

Potato Cyst Nematodes; Root-Knot Nematodes

Globodera rostochiensis, Globodera pallida; Meloidogyne spp.

Plant-parasitic nematodes, such as the potato cyst nematodes and the root-knot nematodes, feed on and infect the roots of potato plants. Nematodes are very small, less than 1mm in size. The potato cyst nematode (PCN) produces spherical cysts on roots that can be white, yellow or brown, and which contain nematode eggs. Symptoms include leaf wilting, discolouration and yellowing of the leaves, stunted growth, and dwarfing of the plant.

Root-knot nematodes start causing damage in their second juvenile stage, at which point they are vermiform and less than 0.5mm in length. They penetrate the vascular cylinder of the roots. This induces hypertrophy and hyperplasia, which eventually lead to the root formation of characteristic knots. Field symptoms are similar to those of PCN, which include stunted growth and yellowing of leaves. Tubers may also exhibit yellowing, stunting, brown spots, and the formation of galls.

Management and Control

Agronomic interventions

- Avoid water stagnation.
- Harvest before the cysts mature.
- Implement extensive rotations with non-host crops (cereals, legumes, composites, lilies). Avoid cultivation of potatoes, especially in fields where there is a known presence of nematodes, for at least 4 to 5 years.
- Where possible collect before cysts mature.
- Use varieties resistant to the Ro1 biotype of G. rostochiensis.
- Use Brassicaceous seed meals at a rate of 2.5 t/ha, 7-10 days before transplanting, at a depth of 15–20 cm in soil with subsequent watering.
- Use catch crops (eg. Brassicaceae which contain a natural nematocide) as green manuring.

Chemical interventions

Intervene in case of ascertained presence of nematode cysts in soil or if their presence was recorded in the previous year.

PLANT PROTECTION SUBSTANCES AND DEVICES

- *Paecilomyces lilacinus*
- Fluopyram (1)
- Fosthiazate (2)
- Oxamyl (2)

LIMITATIONS OF USE & SPECIAL CONDITIONS

(1) Do not exceed two applications from compounds Fluopyram and Fluxapyroxad. In instances where application is carried out at pre-sowing stage, always intervene with this compound in alternate years.

(2) Alternate between Fosthiazate and Oxamyl products on a yearly basis. Do not use product recurrently.

Meloidogyne sp. damage on tuber [22]

Meloidogyne sp. forming galls on roots [24]

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