Feed the Future Tanzania Kilimo Tija Project

Technical Bulletin: Pest and Disease Identification and Management for Irish Potatoes

INTRODUCTION

Irish potatoes (Solanum tuberosum) are a staple crop in Tanzania, valued for their nutritional benefits and economic potential. However, the productivity of this crop is often compromised by various pests and diseases – too many to fit into a brief technical bulletin. Therefore, this bulletin provides insights into identifying the three most common pests and three most common diseases affecting Irish potato production in Tanzania and outlines integrated management strategies to mitigate their impact.

Figure 1: An Irish potato demonstration plot in Intokera village, Rungwe. The plot is owned and managed by the Mshikamano Youth Farmer Group, with support from KTP.
Photo: Fintrac Global Inc.

A. PESTS

I. POTATO TUBER MOTH / TUBERWORM (Phthorimaea operculella)

The moth, specifically Phthorimaea operculella, is recognized as the most widespread potato insect worldwide. In tropical and subtropical regions, this moth, or its larval form known as the worm, is considered the most critical pest of potatoes.

Impact

Typical damage is caused by larvae that bore tunnels into tubers. The larvae leave behind excrement, rendering the tubers inedible. Severe infestations can lead to significant losses in yield and quality, particularly during storage when infested tubers are stored alongside healthy ones. This often results in the total destruction of the stored potato crop. Additionally, the damage from tuber moths creates entry points for other pathogens, potentially leading to tuber rot.

Figure 2: Symptoms of potato tuber moth (A, B): larvae infestation on leaves (B) and on tubers (C, D). *Photos: International Potato Center (CIP)*

Identification Tips: Look for small moths with grayish wings around the crop. Larval presence is confirmed by finding tunnels filled with black frass in tubers.

- Egg: Size is 0.5 x 0.35 mm, whitish and turning to yellowish, deposited singly or in small batches (Figure 2A).
- Larvae: The first instar larva of the moth starts at about 1 mm in length, while the fourth instar larva can grow to between 9 and 13 mm. The color of the larvae varies depending on their diet; those feeding inside tubers exhibit a whitish-purple hue, whereas larvae that consume potato leaves range from purple to green (Figure 2B).
- Pupae: The pupae measure 7–8 mm in length. Initially, they appear brownish in color but gradually darken to almost black as they mature, just before the emergence of the adults (Figure 2C).
- Adult: The moth displays a brownish-gray coloration, with noticeable fraying along the posterior edge of the forewings and both the posterior and inner edges of the hindwings. When at rest, the moth's wings are folded to form a roof-like shape over its body. The size of the moth in its resting position ranges from 7 to 9 mm, and it has a wingspan of 12 to 16 mm (Figure 2D)

Monitoring Techniques

- Effective monitoring of the Potato Tuber Moth is crucial for timely intervention and management. Here are some key techniques used to monitor this pest in potato crops:

Pheromone Traps

- **Description**: Pheromone traps use sex pheromones to attract male moths. These traps are highly effective for detecting the presence and estimating the population density of male tuber moths.
- **Application**: Place pheromone traps around the perimeter of the field and near potential breeding sites. The number of moths captured in these traps provides a good indication of the population levels and helps in determining the timing of control measures.

Figure 3: The developmental stages of potato tuber moth, *Phthorimaea operculella*: (A) egg, (B) larva, (C) pupa, and (D) adults female (left) and male (right). *Photos: CIP*

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Visual Inspection of Plants

- **Description**: Regular visual inspections can help detect early signs of infestation. Focus on examining the foliage for larvae and damage, such as holes or mining patterns on leaves and stems.
- **Application**: Inspect plants weekly during the growing season. Pay special attention to the lower leaves and stems, which are preferred sites for egg-laying by the female moths.

Tuber Inspection

- **Description**: Direct examination of tubers during and after harvest can reveal the extent of infestation by tuber moth larvae.
- **Application**: Randomly sample a set number of tubers from different parts of the field. Look for entry holes and the presence of larvae or their frass. This method provides crucial data on the effectiveness of field management and the need for post-harvest interventions.

Light Traps

- **Description**: Light traps attract and capture flying adult moths during the night. These traps are useful for monitoring adult moth activity and can help predict outbreaks.
- **Application**: Install light traps at strategic locations within the field. Regularly check and record the number of moths caught to assess activity levels and peak flight periods.

Soil Examination

- **Description**: Since larvae and pupae of the tuber moth can reside in the soil, examining soil samples can provide insights into the population's developmental stages.
- **Application**: Periodically take soil samples from within and around the potato field, particularly near the plant base where larvae might drop to pupate. Look for pupae which are indicative of an ongoing or impending infestation.

Management Strategies

Given the global importance of the potato tuber moth, the most effective pest control is achieved through integrated pest management when a range of management methods are applied. Thereby, management techniques focus on both prevention of storage infestation and control of the pest in the field.

- **Cultural Controls:** Implement good agricultural practices such as crop rotation with non-host crops to break the life cycle. Harvest potatoes as soon as they mature to minimize exposure.
- **Biological Controls:** Introduce parasitic wasps like Copidosoma koehleri, which target the eggs and larvae of the tuber moth. Promote beneficial insects by planting nectar-producing flowers around the field.
- **Chemical Controls:** Use specific insecticides that target larvae, applying them at the first sign of infestation. Insect growth regulators can disrupt the development of larvae without affecting beneficial insects.
- **Integrated Management:** Combine early harvesting and immediate post-harvest processing with the strategic use of biological agents and selective insecticides to manage populations effectively.

II. APHIDS

Aphids, particularly the green peach aphid (*Myzus persicae*), are significant pests in potato cultivation due to their ability to transmit deadly viruses such as the potato leafroll virus and potato yellow leaf virus .These tiny, soft-bodied insects feed on the sap of potato plants, weakening them and facilitating the spread of these viruses.

Impact

Infestation leads to direct damage from feeding and more critically, virus transmission, which can severely diminish crop yield and quality.

Figure 4 (Left): Nymph, wingless adult, and winged adult green peach aphid Avocado brown mite damage causes bronzing on the upper leaf surface.
Figure 5 (Right): Green peach aphids. *Photos: UMass Amherst*

Identification Tips

Aphids are small (1.5 to 2.5 mm) and can be wingless or winged. The wingless form is usually light green to translucent but can also appear pink or peach. Winged aphids, which pose a greater threat due to their mobility, have a dark brown to black head and thorax, and their abdomen may be green, pink, or dull red with a characteristic black patch.

Monitoring Techniques

Effective management begins with accurate and timely monitoring using techniques that help track aphid populations and their dynamics within potato fields.

- **Aphid/Plant Counts:** Also known as the "beating method," this technique involves shaking plants over a light-coloured board or sheet to dislodge aphids, which are then counted. This method is best used early in the season when aphid populations are low to detect initial migrations into the field.
- **Aphid/Leaf Counts:** As plants mature, it's advisable to perform weekly aphid/leaf counts by examining three fully expanded leaves from different parts of each plant. This method helps in monitoring aphid infestations as the crop grows and is particularly useful in fields visited less frequently.
- **Yellow Water Traps:** These traps use water in containers painted yellow colour that attracts aphids, especially Myzus persicae. The traps are placed in the field and checked regularly to measure aphid flight and infestation levels. The water is mixed with a bit of detergent to break surface tension, ensuring that aphids that fall into the traps are retained.

Management Strategies

With a clear understanding of aphid activity through diligent monitoring, the following integrated pest management strategies can be employed: As mites are generalist pests, most species can be controlled using similar methods. Weekly scouting is crucial for making informed spraying decisions.

- **Cultural Controls**: Implement crop rotation and intercropping to disrupt aphid life cycles. Removal of plant residues and volunteer potatoes that may harbor aphids is crucial.
- **Biological Controls**: Encourage natural predators like ladybugs, lacewings, and parasitic wasps. Biological insecticides based on fungi or bacteria that target aphids can also be effective.
- **Chemical Controls**: Insecticidal soaps and oils can be used for managing low to moderate infestations. For more severe infestations, systemic insecticides might be necessary. However, their use should be judicious to avoid resistance buildup and minimize impact on beneficial insects.
- **Integrated Management**: Combine monitoring with targeted biological and chemical interventions based on threshold levels determined from monitoring data. This ensures treatments are only applied when necessary, optimizing resource use and minimizing environmental impact.

III. CUTWORMS

Cutworms are early season pests that can cause significant damage to potato crops by severing young plants at the soil surface.

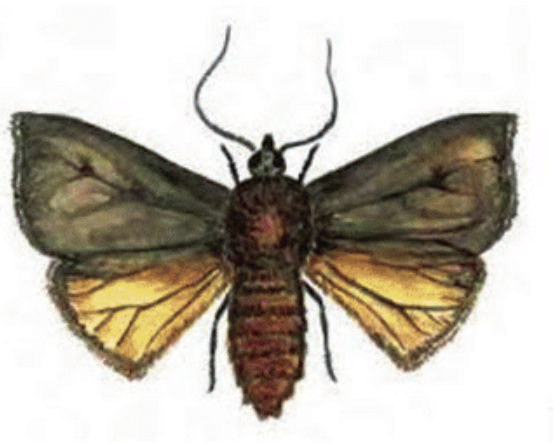
Impact

Cutworms typically attack the stems of young potato plants at or just below the soil line, cutting them off completely. This can result in substantial stand reductions and compromised plant development early in the growing season.

Identification Tips

Cutworms are moth larvae that reside in the soil and emerge at night to feed on plants.

- **Egg:** Eggs are laid in clusters on leaves near the soil surface and are small, round, and creamy white.
- **Larvae:** They are stout, smooth, and vary in color from gray to black or brown; they curl up when disturbed.
- **Pupae:** Pupation occurs in the soil; pupae are brown and segmented.
- **Adult:** Adult moths are night-flying and less frequently seen. They have dark forewings with lighter markings.

Figures 6, 7, 8 (Left to Right): Cutworm larva, pupa, and adult.
Photos: Kroschel, Jürgen & Mujica, Norma & Okonya, Joshua & Alyokhin, Andrei. (2020). Insect Pests Affecting Potatoes in Tropical, Subtropical, and Temperate Regions.

Monitoring Techniques

Accurate monitoring is essential to initiate timely control measures against cutworms.

- **Soil and Plant Inspections:** Regularly inspect the soil and base of plants, especially after transplanting, for larvae and signs of feeding.
- **Pheromone Traps:** Place pheromone traps around the field to catch adult moths and monitor moth activity, indicating potential egg laying.
- **Light Traps:** Use light traps to attract and capture adult moths, providing insight into the population size and peak activity periods.

Management Strategies

Effective management of cutworms includes cultural, biological, and chemical controls.

- **Cultural Controls:** Till the soil before planting to expose and destroy larvae and pupae. Remove plant debris and weeds around the field to reduce egg-laying sites.

- **Biological Controls:** Promote natural predators such as birds and ground beetles. Bacillus thuringiensis (Bt) formulations can be effective against younger larvae.
- **Chemical Controls:** For chemical control of cutworms in Irish potatoes, several effective agents from the PERSUAP list can be utilized. These include Imidacloprid, Azadirachtin, Acetamiprid, Beauveria bassiana, Thiamethoxam, Abamectin, and Dimethoate.
- **Integrated Management:** Combine regular monitoring, cultivation practices, and biological controls for a holistic approach. Adjust planting schedules or use row covers to protect young plants when cutworm activity is high.

B. DISEASES

Effective disease management is crucial for sustaining the health and productivity of Irish potato crops. Diseases not only affect the yield but also impact the quality of the potatoes, making them less marketable and potentially leading to significant economic losses. This section focuses on Fusarium Wilt, Bacterial Wilt, Early Blight and Late Blight — some of the most detrimental diseases affecting potatoes in Tanzania.

I. FUSARIUM WILT (Fusarium oxysporum)

Fusarium wilt is caused by the soil-borne fungus *Fusarium oxysporum*, which specifically targets the vascular system of potato plants, disrupting their ability to transport water and nutrients.

Impact

This fungal disease causes a progressive yellowing and wilting of leaves, starting typically at the base and moving upwards, leading to stunted growth and potentially plant death. The unilateral wilting pattern is characteristic, affecting one side of the plant more severely than the other. The fungus can survive in the soil for extended periods, making it challenging to control.

Identification Tips

- **Leaves:** Initial symptoms include yellowing of the lower leaves, progressing to a general wilting. The leaves may appear water-soaked and wilted.
- **Stems:** Cut open the stem of an infected plant. If you observe brown or reddish-brown discoloration in the vascular tissue (the part responsible for water and nutrient transport), it's likely Fusarium wilt.
- **Roots:** When you cut the roots, look for brown streaks or discoloration in the vascular system. Infected plants often have fewer and smaller roots due to impaired water and nutrient uptake.

Monitoring Techniques

- **Soil Testing:** Conduct comprehensive soil tests to identify the presence of *Fusarium* spores, particularly prior to planting, to assess risk levels and guide soil treatment decisions.
- **Plant Inspection:** Engage in routine inspections, focusing on the earliest signs of yellowing and wilting, to initiate immediate countermeasures.

Management Strategies

- **Cultural Controls**: Implement strict crop rotation protocols with non-host crops for a minimum of three to four years to disrupt the life cycle of the fungus. Enhance soil drainage and structure to reduce moisture levels conducive to fungal growth.

- **Chemical Controls**: At the onset of plant growth, apply targeted fungicides that are effective against Fusarium species to prevent disease establishment. Suitable options include Azoxystrobin, Bacillus subtilis, and Trichoderma spp.
- **Integrated Management**: Leverage a combination of resistant potato varieties, optimized irrigation practices to maintain moderate soil moisture, and precise fungicide applications to effectively manage Fusarium wilt.

Figure 9 (Left) Fusarium wilt present on potato leaves. *Photo: Howard F. Schwartz, Colorado State University, Bugwood.org*
Figure 10 (Right) Fusarium wilt in a potato stem. *Photo: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org*

II. BACTERIAL WILT (Ralstonia solanacearum)

Bacterial wilt, triggered by *Ralstonia solanacearum*, stands as one of the most devastating bacterial diseases impacting potatoes, characterized by its swift progression and severe impact on plant vitality and tuber integrity.

Impact

The infection rapidly leads to a profound wilting and yellowing of foliage, culminating in the plant's total collapse. This not only drastically diminishes yield but also deteriorates tuber quality.

Identification Tips

- **Leaves:** Wilting typically initiates at the leaf margins and progressively moves inward, with leaves turning flaccid and acquiring an oily sheen, a sign of systemic infection.
- **Stems:** Cutting into the base of the stem might show a milky white liquid, which is a clear sign of infection.
- **Soil and Water Testing:** Regularly test both soil and irrigation water for traces of *Ralstonia solanacearum* to gauge infection risk and guide cultural practices.
- **Symptomatic Inspection:** Conduct systematic inspections for early detection of wilting symptoms and the characteristic ooze, enabling prompt intervention.

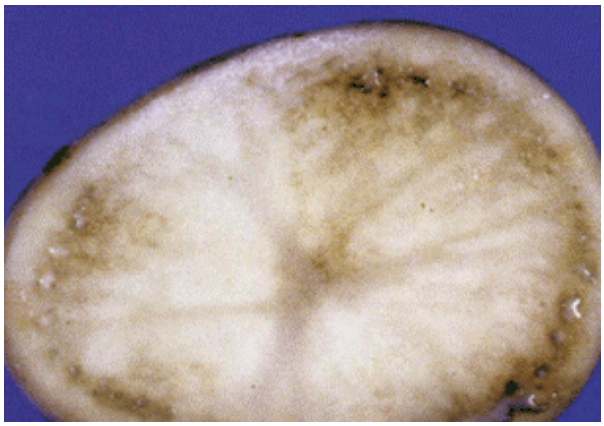


Figure 11 (Left) Grey-brown discoloration of vascular tissues and bacterial ooze in potato tuber infected by R. solanacearum. *Photo: K. Tsuchiya*
Figure 12 (Right) Bacterial ooze exuding from eye of potato tuber infected by R. solanacearum. *Photo: Central Science Laboratory, Harpenden Archive, British Crown, Bugwood.org*

Management Strategies

- **Cultural Controls:** Use disease-free seed potatoes and avoid planting in contaminated fields. Manage water carefully to prevent too much moisture.
- **Chemical Controls:** While options are limited, copper-based bactericides can offer some level of disease suppression if applied early and correctly.
- **Integrated Management:** Follow strict field cleanliness, rotate crops with plants that aren't affected by this bacterium, and manage water properly to control bacterial wilt effectively.

III. EARLY BLIGHT (Alternaria solani)

Early Blight is caused by the fungus *Alternaria solani*. It primarily affects the leaves and stems but can also impact the tubers.

Impact

This disease manifests as circular or irregular dark brown spots on the leaves, often surrounded by a yellow halo. The spots may grow and merge, leading to significant leaf loss, reduced photosynthesis, and weakened plants.

Identification Tips

- **Leaves**: Look for small, dark brown lesions that expand to form concentric rings, creating a 'target' or 'bullseye' appearance.
- **Stems and Tubers**: Dark, sunken lesions on stems and at the tuber surface can also occur, particularly in moist conditions.

Figure 13 (Left) Potato early blight lesion on a potato leaf. *Photo: Syngenta Canada*
Figure 14 (Right) Potato early blight on a tuber. *Photo: Ontario Ministry of Agriculture and Food*

Monitoring Techniques

- **Visual Surveys:** Regularly inspect leaves for early signs of lesion formation, especially after rain.
- **Weather Monitoring:** Track local weather conditions as prolonged leaf wetness and high humidity facilitate the spread of the fungus.

Management Strategies

- **Cultural Controls:** Implement good field sanitation, remove plant debris, and avoid overhead irrigation to reduce leaf wetness.
- **Chemical Controls:** At the start of the growing season, apply protective fungicides such as Azoxystrobin, Difenoconazole, Copper, Mancozeb, and Tebuconazole to guard against diseases. If a disease is detected, the use of curative fungicides should be considered to manage and control the infection effectively as listed in our PERSUAP.
- **Integrated Management:** Combine resistant varieties, timely fungicide applications, and crop rotation with non-host crops to effectively manage early blight.

IV. LATE BLIGHT (Phytophthora infestans)

Late Blight is caused by the oomycete *Phytophthora infestans*. It is one of the most devastating diseases of potato, capable of destroying entire fields rapidly.

Impact

This disease causes dark blotches on leaves and stems which quickly turn into large, rotting areas. Infected tubers develop a reddish-brown decay beneath the skin, which is soft and can emit a foul odor.

Identification Tips

- **Leaves:** Initial symptoms are small, greenish-black spots that expand rapidly under wet conditions, often accompanied by white fungal growth on the underside of the leaves.

Figure 15 (Left) During active late blight growth, especially in cool, wet weather, a white mildew-appearing area is visible at the edge of the lesions. *Photo: Eugenia Banks, Ontario Ministry of Agriculture and Food*
Figure 16 (Right) Late blight causes a tan to reddish-brown, dry, granular rot found under the skin in the discolored areas and extending into the tuber. *Photo: Andy Robinson, NDSU/University of Minnesota*

- **Tubers:** Look for dark, reddish-brown, firm decay under the skin, often starting at the tuber's surface.
- **Spore Traps:** Use spore traps to detect the presence of Phytophthora infestans spores in the air.
- **Environmental Sensors:** Monitor humidity and temperature as high moisture and moderate temperatures (15-21°C) can accelerate disease development.

Management Strategies:

- **Cultural Controls:** Avoid fields known to be previously infected, improve drainage, and implement wider spacing to reduce humidity around the plants.
- **Chemical Controls:** Utilize systemic fungicides such as Azoxystrobin, Metalaxyl-M, Bacillus subtilis, Trichoderma spp., Dimethomorph, Mancozeb, and Cymoxanil, applying them regularly throughout the growing season. It is particularly crucial to apply these fungicides before anticipated rainfall to ensure effective disease management and prevention.

Figure 17: KTP beneficiary, Ms Huruma Mgaya an Irish potato producer at Mtwango Njombe DC.
Photo: Fintrac Global Inc.

- **Integrated Management:** Employ disease-resistant varieties and combine with accurate weather monitoring to apply fungicides only when necessary.

CONCLUSION

Effective management of diseases and pests is crucial for the sustainable production of Irish potatoes. This technical bulletin has provided detailed insights into the identification, monitoring, and control of some of the most critical pest and disease threats to potato cultivation. By integrating various management strategies ranging from cultural practices and biological controls to the judicious use of chemical treatments growers can protect their crops, enhance yield quality and quantity, and ensure the longevity of their farming operations.

It is essential for growers to remain vigilant, regularly monitoring their fields for any signs of disease or pest activity and responding promptly to any threats. Adaptation and flexibility in management practices, guided by ongoing observation and the latest agronomic research, will be key to addressing the dynamic challenges posed by pests and diseases in Tanzania.