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Integrated pest management of potatoes

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ABSTRACT

The potato (*Solanum tuberosum* L.) is the most important dicotyledonous source of hu- man food. It ranks fifth major food crop of the world, exceed only by the grasses such as wheat, rice, maize, and barley. It is characte- ristically a crop of the cool, temperate regions or of elevation of approximately 2000 m or more in the tropics. It requires cool nights and well drained soil with adequate moisture and does not produce well in low altitude, warm, tropical environment. Commercial production of most potatoes is primarily through vegetative propagation by means of lateral buds formed on the tuber, a modified stem. Trough such vegetative propagation, many diseases are transmitted from generation to generation. Suppression of such diseases and reduction of yield losses due to disease are a necessary part of increasing the food supply. The principles, strategies, and tactics of plant disease management are important to preventing yield losses. Integrated pest management (IPM) may supply effective control of the potato pests including aphids (vector of some viruses), *Verticillium* wilt blackleg, bacterial ring rot, Rhizoctonia, Phytophthora infestans (late blight) and several weeds (night shades, pigweeds, lambs quarters, and annual grasses). It includes regular inspection for healthy seed or nursery, crop production, correct identification of the problem, cultural practices (crop rotation, sanitation *etc.*), biological control, soil fumigation (if necessary), seed or nursery stock treatment and disinfestations of cutting tools. In this review, pest management methods of potatoes included in IPM was summarized.

Keywords: Potato; IPM; Pests and Diseases

1. PEST MANAGEMENT PROGRAM

No single management program is suitable for all potato crops. Pest problems vary from field to field and season to season because of differences in soil type, cropping history, cultural practices, cultivar, and the nature of surrounding land. Choice of market and market conditions also affect the feasibility of management options because they determine how a crop must be handled and the value of that crop. Regardless of conditions, however, four components are essential to any IPM program: 1) Accurate pest identification 2) field monitoring 3) control action guidelines 4) effective management methods [1].

Because most pest management tools, including pesticides, are effective only against certain pest species, one must know which pests are present and which are likely to appear. Different control methods may be needed even for closely related species.

By monitoring his field, one can get the information he needs to make management decisions. Monitoring includes keeping records of weather, crop development, and management practices, as well as evaluating incidence and levels of pest infestations.

Control action guidelines indicate when management actions, including pesticide applications, are needed to avoid losses due to pests or other stresses. Guidelines for most pathogens and weeds are usually based on the history of a field or region, the stage of crop development, observed symptoms or damage, weather conditions, and other observations

2. MANAGEMENT METHODS

2.1. Seed Quality and Certification

A number of pests can be transmitted in infected seed tubers, including bacterial ring rot, blackleg, common scab, late blight, potato viruses, powdery scab, *Rhizoctonia*, root knot nematodes, silver scurf, and wilt diseases. In order to prevent these problems, one must start with healthy stock [2]. Stem cutting and micro-propagation techniques have been developed to obtain pest-free potato plants for propagation and production of certified seed tubers. Disease-free stem cuttings or tiny pieces of meristem tissue are cultured and propagated under sterile conditions to produce large numbers of disease-free plantlets or mini tubers. Several generations of plants are grown in the field to produce certified seed tubers that will be sold to commercial growers [3].

Extra precautions are taken to reduce the incidence and spread of pests in fields where seed potatoes are grown. Most seed potatoes are grown in cool, short season areas where pest populations, including vectors of potato viruses, remain low and the symptoms of infected plants easier to recognize. Ideally, seed fields are isolated from commercial fields and home gardens from which potato viruses could be transmitted by aphids.

2.2. Biological Control

Any activity of a parasite, predator, or pathogen that keeps a pest population lower than it would be otherwise is considered biological control. One of the first assessments that should be made in an IPM program is the potential role of natural enemies and hyperparasites in controlling pests. Control by natural enemies and hyperparasites is inexpensive, effective, self-perpetuating, and not disruptive of natural balances in the crop ecosystem.

Natural enemies that affect nematodes, weeds, and fungi are being studied, but as yet no practices are recommended for improving biological control of these pests. Bacteria antagonistic to *Erwinia caratovora* are being developed as seed piece treatments for reducing seed piece decay and blackleg. Among rhizobacteria *Agrobacterium radiobacter*, *Bacillus subtilus* and *Pseudomonas* spp. are antagonistic to potato cyst nematodes (*Globodera pallida* and *G. rostochiensis* although *Pasreuria penetrans* attach PCN [4]. Larkin [5] reported that soil-application of aerated compost tea (ACT) and the combination of ACT with a mixture of seven different mycorrhizal fungus species belong to *Glomus* spp. reduced stem canker, black scurf, and common scab on tubers by 18% - 33% and increased yield 20% - 23% in the barley/ryegrass rotation, but not in the other rotations.

2.3. Resistant Cultivars

Plant breeding is one of the most powerful tools available for both the management of pests and the production of the best crop. Pest management is one of many factors that must be taken into account when choosing cultivars. Cultivars resistant or tolerant to disease can help reduce losses caused by some soil-borne pathogens and provide long-term, economical protection from conditions that otherwise could inflict severe losses every season.

Part of every breeding program is the search for resistance to serious diseases, disorders, and nematode pests. Resistance to insect pests is being investigated. New potato breeding selections are assessed for resistance to several viruses, leaf-roll net necrosis, root-knot nematodes, *Verticillium* wilt, scab, blackleg, early blight, and several physiological disorders [6].

2.4. Chemical Control with Pesticides

Properly used, pesticides can provide economical protection from pests that otherwise would cause significant losses. In many situations, they are the only feasible means of control. Careless or excessive use of pesticides, however, can result in poor control, crop damage, higher expenses, and hazards to health and environment. In an IPM program, pesticides are used only when field monitoring indicates they are needed to prevent losses.

Fungicides can reduce damage caused by certain foliar pathogen such as powdery mildew, late blight, and severe early blight. To be effective, they usually must be applied before infection occurs or when the disease just begins to develop. Soil fumigants may be used to control nematodes or *Verticillium*.

3. CULTURAL PRACTICES

Proper management of the potato crop, from field preparation and planting through harvesting and storage is essential for maximum yields of high quality tubers. Many cultural practices including seed selection and handling, planting, irrigation, fertilization, vine killing, careful harvesting methods have a significant impact on pest damage. Even when you cannot choose cultural methods solely for their effect on pest management, it is important to understand their impact on pests so that you will know what to expect.

Careful water management helps prevent Rhizoctonia and piece decay early in the growth of the plant, reduces tuber malformation and symptoms of *Verticillium* wilt during the season, the severity of scab, and helps prevent tuber rots as plants mature and die. Excess fertilization of indeterminate cultivars delays tuber growth and may reduce yields [7]

3.1. Sanitation

Sanitation is essential to the prevention of seed piece infection during cutting and handling, and prevention of spread of the pathogens in contaminated soil, water, and field equipment. Strict sanitation requirements must be followed in growing seed potatoes.

Any potato cull piles should be destroyed or sprayed to ensure that no Phytophthora sporangia will be blown from there to the potato plants in the field later on. Cull potatoes are excellent hosts for potato diseases and can provide a safe haven for potato insects to increase in numbers. Important pests that can be harbored in waste potatoes include late blight, potato leaf roll virus (PLRV), bacterial ring rot, and nematodes. Soil associated with cull potatoes can be infested with pests such as powdery scab, nematodes, and weed seeds. Waste potatoes must be handled correctly to eliminate these and other potential dangers [8]. Tubers are cut with disinfested knifes to reduce spread of ring rot among seed pieces and the seed pieces usually treated with a fungicide, a bactericide, and an insecticide to protect them from pathogens on their surface or in the soil [2].

3.2. Crop Rotation

Proper crop rotations enhance soil fertility, maintain soil structure, reduce certain pest problems, increase soil organic matter, and conserve soil moisture [3]. Generally, most useful rotations for potato fields are forage crops and grains, including corn. Crop rotation is useful for control of soil-inhabiting pathogens that have limited host ranges and require host plant residues for survival. Rotation is less effective for pathogens such as *Verticillium* spp. or *Phytophthora erythroseptica*, which can survive in the soil for a long time in the absence of host. It is best not to follow a potato crop with another, and rotation with legumes, corn, or other unrelated crops will reduce the population of potato pathogens. Soil populations of beneficial culturable bacteria and overall microbial activity which is suppressive to potato pathogens tended to be highest following barley, canola, and sweet corn rotations, and lowest with continuous potato [9].

3.3. Seed Treatment

Seed piece decay frequently involves a *Fusarium fungus* acting synergistically with bacteria. Therefore, chemical seed treatments, which primarily act as fungicides, are useful when conditions favor development of Fusarium on seed pieces.

3.4. Irrigation

Availability of soil water is a major factor that determines yield and quality of the potato crop. Too little water will reduce yields, induce tuber malformations, or increase severity of scab or *Verticillium* with symptoms. Excess or poorly timed irrigation may reduce yield or in storage or leach nutrients from root zone. Fluctuations in water availability favor disorders such as second growth and internal necrosis.

Sprinkler systems provide the most flexibility and most efficient water application, and fertilizers and some pesticides can be applied through sprinklers. Sprinkler irrigation provides conditions in the canopy that are favorable for certain diseases such as early blight, late blight, and white mold (*Sclerotinia* spp.). To reduce spread of these diseases, foliage should be allowed to dry out between irrigations.

3.5. Fertilization

Adequate nutrient availability throughout the growing season is necessary for the best yield and quality. If nutrient deficiencies occur during tuber growth, the plant shunts nutrients from the stems and leaves to the growing tubers, thereby hastening aging of the vines and yields are reduced. On the other hand, excess fertilizer delays the onset of tuber growth in indeterminate cultivars and may reduce their yields; tuber decay after harvest may also be increased and processing qualities such as specific gravity may be lowered.

3.6. Harvest

Before harvest, the infected vines must be killed with chemicals to destroy late blight inoculum that could be in contact with the tubers when they are dug up [2].

Prevention of bruising is one of the most important considerations in a well managed harvest operations. Blackspot and shatter bruise can seriously affect marketable yield if precautions are not taken to reduce them [3].

3.7. Sprout Inhibitors

Sprout inhibitors should be applied to fresh market or processing potato tubers that are to be stored for more than 2 to 3 months. Low storage temperature cannot be used to prevent sprouting without undesirable accumulation of sugars. Foliar applications of sprout inhibitors are used: One, maleic hydrozide, is applied to potatoes while they are still actively growing; the other, chlorpropham (CIPC), is applied through the ventilation system in storage. These sprout inhibitors should never be applied to seed potatoes.

3.8. Storage

A large part of the crop in most growing areas is stored for fresh market or processing during the winter and spring. Design can vary but most storage facilities have controls for temperature, humidity, and ventilation. Ventilation is essential during storage. It removes heat and excess moisture that may condense on colder tubers, and heat produced by respiration; at the same time it helps provide even temperature and humidity within the storage area and oxygen to support tuber respiration.

Uniform airflow throughout the pile is important.

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