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12. Recent Approaches of Potato Disease Management

Rohit Kumar Singh

Assistant Professor,
Teerthankar Mahaveer University,
Moradabad, U.P., India,

Vishwa Jyotsna Singh

Kumaun University,
Nainital, Uttarakhand, India.

Vijay Bagare

Assistant Professor,
Mangalayatan University,
Jabalpur, M.P., India,

Vinay Kumar Singh

Assistant Professor,
Shri Venkateshwara University,
Gajraula, U.P., India.

Abstract:

Various diseases pose substantial obstacles to potato agriculture, reducing productivity and quality. Recent developments in disease management have included integrated techniques that mix traditional methods with novel technologies. This abstract discusses modern methods to potato disease control, with a focus on advances in disease-resistant cultivars, integrated pest management (IPM), and cutting-edge technologies like genomics and remote sensing.

Genetic advancements have resulted in the production of potato cultivars that are more resistant to major diseases such as late blight, early blight, and bacterial wilt. These kinds are produced using standard breeding procedures and genetic alteration, providing a long-term answer to disease management. Modern IPM systems combine biological control agents (e.g., beneficial microorganisms and insects) with chemical treatments and cultural practices. This comprehensive approach seeks to reduce the burden of illnesses while lowering dependency on chemical inputs and preventing resistance development. Advances in genomics have made it easier to identify disease resistance genes and create molecular markers for breeding. Remote sensing technology, such as satellite imaging and drones, allow for early identification and monitoring of disease outbreaks, resulting in prompt and precise action.

Keywords:

Potato diseases, Disease management, Genetic resistance, Genomics, Sustainable practices

12.1 Introduction:

India is an agriculture-based country, and agriculture (along with its allied sectors) is the largest livelihood provider, for achieving: (i) no poverty, (ii) zero hunger, (iii) food health and well-being, the three of the seventeen Sustainable Development Goals (SDGs) adopted by the United Nations (to be achieved by 2030), much depends on the growth and performance of the agriculture sector. Furthermore, India is expected to be the most populous country in the world by 2050. Diversification and the use of horticulture crops would be the most essential strategy for ensuring the food and nutritional security of the growing population.

This emphasizes the importance of horticulture crops in Indian agriculture, as well as the future focus on horticultural crop research and development Jones (1998). Potato is an important horticulture crop, and because of its ability to generate the most nutrition and dry matter per unit area and time among key food crops, the FAO designated it as the crop to address future global food security and poverty alleviation in 2008. Potato, as a 'commodity for class and mass', has enormous potential to help achieve the three SDGs mentioned above Shiferaw *et al*., (2018).

Within just seventy-five years of its journey as an independent nation, India has surpassed the total potato production of 60 million tons and the average yield of 25 t/ha. This is a remarkable and inspirational milestone for the whole nation in general and for the stakeholders associated with potato in specific. In the years 2021-22, potatoes contributed more than 67000 crores (Gross Production Value) in the Indian economy Brajesh and Som (2024).

Potato (*Solanum tuberosum* sp. *tuberosum*) is not a native crop of India. It was originally domesticated around 8,000 years ago by communities of hunters and gatherers in the Andes Mountain range of South America, on the border between Bolivia and Peru. Though it is believed the conqueror of Peru, Francisco Pizarro was the first European to see potato in 1533.

It is the fourth most important food crop in many countries of the world in terms of quantities produced and it is the third most important crop in terms of consumption after wheat and rice. Potato has a significant impact on providing nutrition to families, increasing household income and employment opportunities.

It is used as the vegetable, stock feeding and in industries for manufacturing starch, alcoholic beverages and other processed products. It provides essential body building substances such as proteins, vitamins, minerals (P, Ca, Mg, K, Fe, S, Cl). Potato is an important food resource globally and cultivated worldwide in over one hundred countries throughout Africa, Asia, Australia, Europe, and North and South America. Some inherent qualities give the potato a competitive edge over the leading crops Shiferaw *et al.*, (2018).

Plant diseases result from complex interactions between a susceptible host plant, a pathogen, and their environment. Human activities like cultural practices including application of chemicals, modify this interaction. Environmental factors such as temperature, moisture, soil pH, wind, light, and soil type play a huge role in disease development and severity Tadesse *et al*., (2021).

Plants are considered tobe diseased when they are infected by a pathogen and their normal development and functioning are disrupted. Hence, plant diseases significantly diminish growth and yield or reduce the usefulness of a plant or a plant product. Plant diseases may also lead to complete destruction of the entire plant under conditions favourable for the disease. Plant diseases can be grouped by the causal agent involved such as fungal diseases, bacterial diseases, and viral diseases Maurya *et al*., (2023 b).

12.2 Major Potato Diseases:

12.2.1 Late Blight:

Late blight is a serious fungal disease of potatoes caused by *Phytophthora infestans* (Mont.) de Bary (Jones, 1998) is the most devastating potato disease of global potato production. It is a fungal disease which attacks the leaves, stems and tubers of potato plants (Mercure, 1998), which rot either in the field or while in storage (Agrios, 2005).

The fungus, *Phytophthora infestans* is best known for causing the devastating Irish potato Famine in the 1840's, which killed over a million of people. Besides potatoes this pathogen can also infect closely related plant like Tomatoes and Petunia. The disease develops most rapidly at low temperatures and high humidity.

The symptoms of the disease are present on lower as well as upper surface of leaves in form of small, pale to brown lesions. Under the conditions of high humidity and low temperatures the lesions extend from the leaves to the petiole and stem (expand length wise). Severe infections cause all foliage to rot, dry out and fall to the ground, stems to dry out and plants to die. Affected tubers display dry brown-coloured spots on their skins and flesh. This disease acts very quickly. If it is not controlled, infected plants will die within two or three days Tadesse *et al*., 2021; Pandey *et al*., 2022).

The disease is controlled by the use of fungicides but in recent years, highly aggressive strains of this disease, insensitive to popular synthetic fungicides have surfaced and created new challenges for potato producers. An increasing severity of late blight in many potato growing areas, a shift in pathogen population towards increased specific virulence and an increasing tolerance to the most effective late blight specific fungicides suggests a need to develop an appropriate disease management strategy Yitagesu (2019).

Survival and spread:

- The pathogen survives in plant debris in the soil.
- It spreads through soil and infected seed tubers.

Favourable condition:

- High humidity
- Low temperature and leaf wetness

A. Management:

a. Cultural Control:

Use short-duration varieties: The model specifies that 7 days moving sum of RH > 85% for at least 90 hr coupled with a 7-day moving sum of temperature between 7.2 and 26.6°C for at least 115 hr would predict appearance of late blight within 10 days of satisfying the conditions (John *et al*., 2019).

Common Cultural Practices:

1. Summer deep ploughing
2. Soil solarization during summer.
3. Field sanitation, rogueing.
4. Avoid water logged conditions in the field.
5. Follow crop rotation.
6. Apply manures and fertilizers as per soil test recommendations
7. Start to grow ecological engineering plants.
8. Sow/plant 4 rows of maize, sorghum, bajra (pearl millet) around the potato crop field as a guard/barrier crop.
9. Stale seed bed technique before sowing.
10. Destroy all the germinated weeds by shallow ploughing before sowing.
11. Use resistant/tolerant varieties.
12. Use healthy, certified and weed seed free tubers.
13. Adopt recommended agronomic practices like field preparation, time of sowing, row and plant spacing, gap filling etc. to obtain the healthy plant stand to reduce the weed menace.

b. Chemical Control:

Spray captan 50% WG @ 600 g in 200 l water (second spray after 5 days interval) orcaptan 50% WP @ 1 Kg in 300- 400 l water/acre or captan 75% WP @ 666 g in 400 lwater/acre (second spray after 8 days interval) or chlorothalonil 75% WP @ 350-500 gin 240-320 l of water/acre (second spray after 14 days interval) or copper oxychloride50% WP @ 1 Kg in 300-400 l of water/acre or copper sulphate 2.62 % SC @ 400 ml in200 l of water/acre (second spray after 3 days interval) or cyazafamid 34.5% SC @ 80ml in 200 l water/acre (second spray after 27 days interval) or dimethomorph 50%WP@ 400 g in 300 l water/acre (second spray after 16 days interval) or mancozeb 75%WG @ 400 in 200 l water/acre (second spray after 3-5 days interval) or mancozeb 75%WP@ 600-800 g in 300 l water/acre or hexaconazole 2% SC @ 1.2 l in 200 l water/acre(second spray after 21 days interval) or mandipropamid 23.4% SC @ 0.2 ml/ l in 200-300 l of water/acre (second spray after 40 days interval) or propineb 70% WP @ 300 gin 100 l of water or 0.30% as required depending upon crop stage and plant protection equipment used (second spray after 15 days interval) or zineb 75% WP@ 600- 800 gin 300-400 l of water/acre or captan 70% + hexaconazole 5% WP @ 200- 400 g in 200 lof water/acre (second spray after 21 days interval) or cymoxanil 8% + mancozeb 64%WP @ 600- 800 g in 200-300 l of water/acre (second spray after 10 days interval) or famoxadone 16.6% + cymoxanil 22.1% SC @ 200 ml in 200-300 l of water/acre (second spray after 27 days interval) or fenamidone 10% + mancozeb 50% WDG @ 500- 600 g in200 l of water/acre (second spray after 30 days interval) or metalaxyl M 4% + mancozeb64% WP @ 025% 1 Kg/ acre in 200-400 l water (second spray after 24 days interval) ormetalaxyl 8% + mancozeb 64% WP @ 025% 1 Kg/ acre in 400 l water (second spray notless than7 weeks) or metiram 55% + pyraclostrobin 5% WG @ 600-700 g in 200 l water/acre (second spray after 15 days interval) or azoxystrobin 23% SC@200 ml in 200 l ofwater/acre or treat tuber with carbendazim 25% + mancozeb 50% WS @ (1.5 + 3.0) to(1.75 + 3.5) for 10 Kg seed (tuber) (Tadesse *et al*., 2021; Maurya *et al*., 2023 a; John *et al*., 2020).

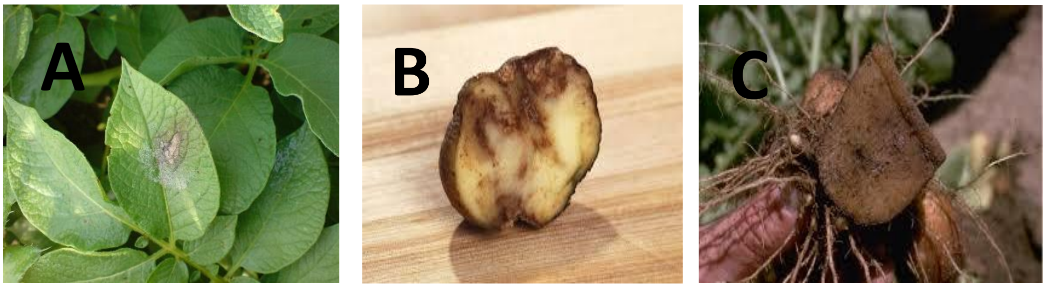

Figure 12.1: (A-C): A.

12.2.2 Early Blight:

Early blight caused by *Alternaria solani,* sorauer is a major foliar disease of potatoes worldwide. The disease occurs over a wide range of climatic conditions and depends in large part on the frequency of foliage wetting from rainfall, fog, dew or irrigation, on the nutritional status of foliage and on cultivar susceptibility Pant *et al*., (2023).

The pathogen can infect all aerial parts of potatoes as well as tubers. The symptoms of the disease occurring on the foliage at any stage of the growth and causes characteristic dark brown to black lesions on the leaf lets, in form of concentric rings a bull's eye pattern can be seen in the centre of the diseased area. Normally the disease symptoms become apparent during tuber bulking stage and develop leading to the harvest. in Tissue surrounding the spots may turn yellow. If high temperature and humidity occur at this time, much of the foliage is killed Zewdu *et al*., (2022). Lesions on the stems are similar to those on leaves, sometimes girdling the plant if they occur near the soil line.

Survival and Spread:

- **Primary:** The pathogen overwinters in infected plant debris in or on the soil where it can survive at least one and perhaps several years. It can also be seed borne.

- **Secondary:** The spores are transported by water, wind, insects, other animals including man, and machinery.

Favourable Conditions:

- Warm, rainy and wet weather

A. Management:

a. Chemical Control:

Spray aureofungin 46.15% w/v. SP @ 0.005% in 300 l of water/acre or captan 50% WG@ 600 g in 200 l of water/acre (second spray after 5 days interval) or captan 50% WP@ 1 Kg in 300- 400 l of water/acre or captan 75% WP @ 666 g in 400 l of water/acre.(second spray after 8 days interval) or chlorothalonil 75% WP @ 350-500 g 240-320 lof water/acre (second spray after 14 days interval) or copper oxychloride 50% WP @1 Kg in 300-400 l of water/acre or mancozeb 35% SC @ 0.5% or 500 g/100 l water 500l water or as required depending upon crop stage and equipment used or mancozeb75% WP@ 600-800 g in 300 l of water/acre or hexaconazole 2% SC @ 1.2 l in 200 l of water/acre (second spray after 21 days interval) or kitazin 48% EC @ 0.20% or 200 ml in 200 l of water or propineb 70% WP @ 300 g in 100 l of water or 0.30% as required depending upon crop stage and plant protection equipment used (second spray after15 days interval) or zineb 75% WP @ 600-800 g in 300-400 l of water/acre or captan70% + hexaconazole 5% WP @ 200- 400 g in 200 l of water/acre (second spray after 21days interval) Zewdu *et al*., (2022).

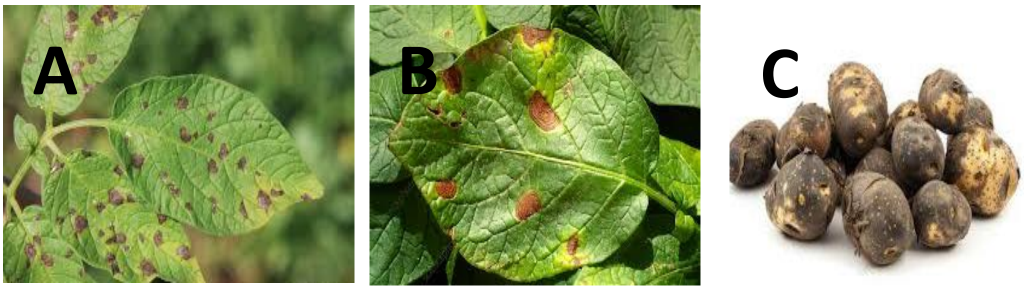

Figure 12.2: (A-C): A.

12.2.3 Common Scab:

The main source of the disease is infected soil. Pathogen infects young developing tubers through the lenticels and occasionally through wounds. Symptoms of common potato scab are quite variable and are manifested on the surface of the potato tuber. The disease forms several types of cork-like lesions. Damaged tubers have rough, cracked skin, with scab-like spots. Severe infections leave potato skins covered with rough black welts. Initial infections result in superficial reddish-brown spots on the surface of tubers. As the tubers grow, lesions expand, becoming corky and necrotic Bera *et al*., (2017).

A. Favourable Conditions:

Disease is common in fields with low soil pH favoured by high soil moisture. Disease problems may be aggravated by excessive irrigation.

B. Control:

Information on less susceptible varieties is available on the National List. Avoid raising soil pH levels with lime prior to growing potatoes. Plant disease free tubers. Irrigate when soil moisture is high and allow the crop to dry out before harvest. There is no chemical treatment available.

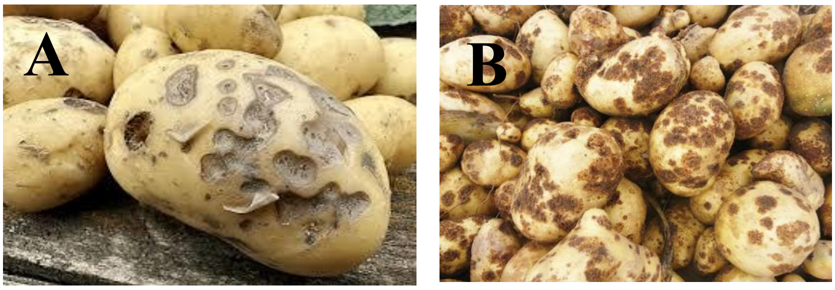

Figure 12.3: (A-B): A

12.3 Integrated Management of Potato Diseases: Past, Present and Future:

Integrated management is a holistic ecosystem approach for crop production and protection with focus on environmental sustainability and economic feasibility. Integrated disease management (IDM) to combat potato pathogens requires the implementation of multiple approaches. A unified management strategy involves, the sound seed certification system, appropriate phytosanitary measures, use of resistant cultivars, need based pesticide application and managing the tubers during harvest and storage Bera *et al.*, (2017). The increasing inter-continental trade in potato poses a threat for emergence and spread of pathogens worldwide. With advancement in the molecular science and computational technology supplemented with increasing awareness of information technology several advancements have been observed in the management of diseases in potato. The most devastating late blight which is a polycyclic disease capable of causing epidemics under favourable conditions must be managed through an integrated approach. These include, phytosanitary measures to reduce the primary inoculum load, prophylactic sprays of fungicides, judicious curative sprays, use of resistant cultivars and early maturing cultivars to reduce duration of infection etc. The early blight disease is mainly controlled by the use of cultural practices (minimize soil born inoculum), growing tolerant and less susceptible cultivars and the use of fungicides Phillip and William (2007). Most potato viruses are managed by using three principal methods: cultural practices, clean seed systems, and host plant resistance. This section gives a comprehensive analysis of traditional and modern management practices (which are an integral component of IDM) against major potato pathogens. An illustration is also made to highlight the IDM principles in potato along with stage specific management strategies.

12.4 Conclusion:

Recent advancements in potato disease management have resulted in a substantial shift in how these important crops are protected and grown. The combination of genetic advancements, technology innovations, and holistic management techniques has significantly improved the efficacy and sustainability of disease prevention programs. Disease-resistant potato cultivars developed through genetic engineering and traditional breeding have proven to be an effective strategy in reducing susceptibility to important diseases such as late blight, early blight, and bacterial wilt. These resistant genotypes reduce the need for chemical treatments, promoting more sustainable farming techniques. Integrated Pest Management (IPM) has grown to include biological controls, cultural techniques, and precise chemical applications, indicating a more nuanced approach to treating potato diseases. By combining these strategies, IPM not only more efficiently targets infections, but it also reduces environmental impact and the possibility of developing resistance. Technological advances, notably in genomics and remote sensing, have transformed illness detection and management. Genomics enables exact identification and inclusion of resistant features, whereas remote sensing technologies provide early detection and real-time monitoring capabilities. These innovations enable more rapid and focused actions, which improves overall management efficiency. Precision agricultural techniques improve disease management by allowing treatments to be applied more accurately based on data-driven insights. This technique maximizes resource utilization while minimizing environmental effect, which is consistent with current sustainability goals.

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