

Management of major insects and nematodes of potato

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Insects and nematodes are major biotic constraints affecting potato yields and tuber quality. On average, potato crops globally face losses of 16% due to insect pests while reductions in tuber yield and quality can be between 30% to 70% for various insect pests. In seed production, aphids, whiteflies and potato cyst nematodes are the most concerning pests.

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THE potato is a widely cultivated horticultural crop around the globe including India. Due to its global distribution, potato is susceptible to a wide range of insect pests. Insect pests cause variable and complex problems for potato farmers. These pests have a significant impact on the yield while quality of potato tubers. On average, potato crops globally face losses of 16% due to insect pests while reductions in tuber yield and quality can be between 30-70% for various insect pests. These pests can cause damage to potato plants by reducing the photosynthetic area and efficiency, weakening stems and inhibiting nutrient transport, and attacking the potato tubers that are intended for consumption or use as seed. In India, an estimated 10-20% of total potato production, valued at approximately ₹ 60 billion rupees, is lost each year due to pest damage. Potato pests can be divided into several categories based on their behaviour. Soil pests, foliage feeders, sap feeders, and storage pests, all pose different challenges to potato growers. In seed production, aphids and whiteflies are the most concerning pests. For ware

production, insects that attack tubers, such as tuber moth, white grubs, and cutworms, are the key pests that growers need to be aware of. In potato crops, foliage feeders like noctuid moths and coccinellid beetles play an important role. Potato cyst nematodes (PCN) and root knot nematodes (RKN) are two of the most economically important nematodes that affect potato crops globally, including India.

Sucking insects of potato

Sucking pests, also known as sap feeders, include aphid, whitefly, leafhopper, thrips and mite. The main economic impact of aphids is as a vector of virus diseases. However, high populations can lead to significant direct losses

as well. Aphids pose the greatest threat to healthy seed potatoes. Identification of insect pests and their damage symptoms as well as integrated management is described in following paragraphs.

Green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera : Aphididae)

Aphids are considered as the most important pest of potato worldwide. Among the aphid species, *Myzus persicae* (Fig. 1) have greatest economic significance due to its virus transmission abilities.

Plant viruses transmitted by aphids are biggest challenge to healthy potato seed production. *M. persicae* is considered as the greatest threat to healthy potato seed production in the plains. Prior



Fig. 1. Wingless *M. persicae*

to the 1960s, potato seed could only be grown in mountainous regions of north India and, to a lesser extent, in southern hills due to strong vector pressure in northern plains. Then, in the 1960s, CPRI conducted large surveys to monitor the arrival and dynamics of insect vectors, particularly *M. persicae*, in the northern plains. According to the surveys, the aphid comes in the first week of January and crosses the economic threshold (20 aphids per 100 compound leaves). Haulm (vegetative part) cutting before the aphid actually crosses the ETL resulted in virus-free seed production on the plains. This technique for growing virus-free seed on the northern plains is popularly known as the seed plot technique (Fig. 2).

Apart from *M. persicae*, *Aphis gossypii* is considered as second most impotent aphid species in potato crop. These aphid species can damage potato directly through sucking sap and thus weaken the plant, indirect losses by transmitting plant viruses. Common potato viruses transmitted by aphids include *Potato virus Y* (PVY), *Potato virus M* (PVM), *Potato leaf roll virus* (PLRV) and *Potato virus A* (PVA).

Whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae)

Whitefly, *B. tabaci* is highly polyphagous responsible for serious direct losses to potato by sucking plant sap besides causing serious economic losses by transmitting



Fig. 3. Whitefly adults

the plant viruses. Whitefly (Fig. 3) transmit causative agent (*ToLCNDV*) of apical leaf curl disease in potato which have been detected in 40 - 70% of potato sample taken from Indo-gangetic plains. Whitefly, *B. tabaci* incidences are more prominent at early growth phase of potato and it occurs at all the potato growing regions of India except the higher altitude of Himalayan region and Western Ghats where potato is being grown during summer season.

Leafhoppers (Hemiptera: Cicadellidae)

In India, the leaf hoppers are distributed in all potato growing regions viz., Punjab, Haryana, Gujarat, Maharashtra, Karnataka, Uttar Pradesh and Bihar where it causes serious menace to potato production. There are many species of leaf hoppers infesting the potato but potato leaf hopper, *Empoasca devastans* Distant is most important species which has been recognized as a major pest of potato. The nymphs feed by sucking plant sap by remaining under surface of leaves. While feeding, leafhoppers inject toxic saliva which causes yellowing,



Fig. 4. Hopper burn in potato

browning, cupping and curling of leaves. The leaf hopper damages in the field can be identified by typical v-shaped burns on leaf tip the crop plants. The margin of the leaves get broken and crumble into pieces when crushed. The severely damaged field gives brunt appearance referred as "hopper burn" (Fig. 4).

The hopper can breed throughout the year but are most active during October to March, coinciding with potato growing season but more severe during early growth phase.

Thrips (Thysanoptera: Thripidae)

In potato, thrips are responsible for direct as well as indirect losses by transmitting tospoviruses. *Thrips palmi* is predominant species on potato in major potato growing areas. The thrips build up are supported by high temperatures (30-35°C) and low relative humidity and these conditions coincide with the early growth phase of potato production during September-October in plains. Both nymph and adult feed on leaves along the midribs and veins and also attack stems particularly at or near the growing tip. Heavy feeding on potato leaves results in development of silver or chlorotic dotting of the tissues and become deformed. With continuous feeding, the tips of leaves wither, curl up and die. Thrips also act as vector of groundnut bud necrosis virus potato which cause stem necrosis disease. Thrips infestation can bring about 15-30% yield loss in potato in northern Gujarat, parts of Madhya Pradesh and Rajasthan.

Integrated management of sucking pests

- Aphid and whitefly populations can be monitored using yellow sticky traps (Fig. 5), yellow water pan traps or manual scouting

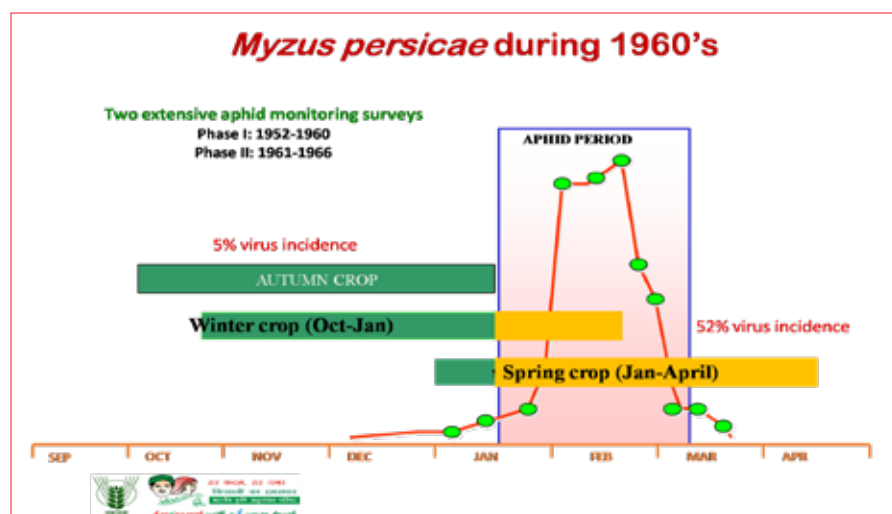


Fig. 2. Seed plot technique

by leaf count method (Fig. 6). The leaf count method consists of counts from 100 compound leaves from upper, middle and lower levels, i.e. taken from 33 plants in a zig-zag manner at random and one leaf from 34th plant.

- Roughing of virus plants exhibiting virus symptoms (Fig. 7) reduces the source of virus inoculums.
- Date of planting play a crucial role in managing aphid borne virus diseases in potato. Recommended dates of planting in the Indo-Gangetic plains, upto 15th October in North-Western plains, upto 25th October in central plains and upto 5th November in the North-eastern plains. The haulm cutting of seed crop should be done as soon as the aphid number crosses the critical level i.e. 20 aphids/100 leaves.
- Seed treatment with Imidacloprid 17.8% S.L @ 0.04% followed by shed drying is recommended for managing

sucking pests.

- A spray schedule of four insecticides is recommended for potato seed crop, however the insecticide for table purpose potato, need based application of insecticides is recommended. Spray of pymetrozine 50 WG @ 0.06% (6g/10 L water) at 80% crop emergence (10-12 days after planting: DAP), a second spray of imidacloprid 70WG @ 0.03% (Doses) after 10-15 days of first spray (25 DAP), a third spray of thiamethoxam 25WG @ 0.05% (5g/10 L water) @ 100g/500 L/ha after 10-15 days of second spray of insecticide (40 DAP) and a fourth spray of flonicamid 50WG @ 0.04% (4 g/10 L water) after 10-15 days of third spray (55 DAP) is recommended in seed potato.
- Under organic potato cultivation, spraying with 0.5% *Verticillium lecanii* (Fig. 8) at 40, 50 and 60 days after planting is recommended for the management of aphids.



Fig. 5. Yellow sticky traps and yellow pan traps



Fig. 6. Pest monitoring



Fig. 7. Virus infected potato plants

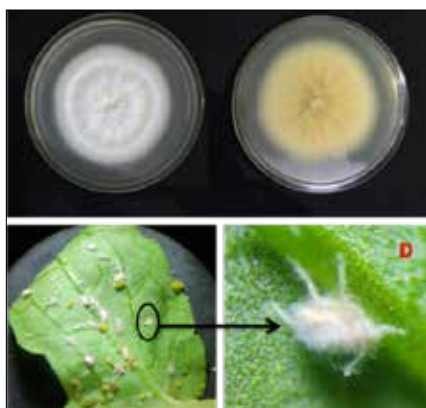


Fig. 8. *Verticillium lecanii* culture and infected aphids

Leaf and tuber damaging pests

Potato tuber moth

Potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) is a major pest of potato throughout the world and a quarantine pest of potato. PTM is principally a storage pest but can damage the crops in field as well. Larvae are the damaging stage of the pest. The larvae enter into the tubers and feed on them causing mines. The activity of larvae in tubers placed in heaps, results in production of heat which causes rotting of the produce significantly. The larvae also mine through the leaves under fields conditions which cause transparent blisters over leaves. Some key management practices include rejecting seed lots from infested fields, avoiding exposure of tubers to the external environment, and monitoring through sex pheromones (20 traps/ha) for early signs of infestation to take timely action. *Bacillus thuringiensis* ssp. *kurstaki* (Btk)-talcum formulation is used to protect tubers in storage against PTM. Potato tubers should be treated (powdered) directly after harvest and placed in storage. Granulosis virus based PhopGV-biopesticide formulated in talcum can also be used to protect stored potatoes. PTM infestations can be particularly damaging, so proactive management is essential to protect potato crops in the field.

White grubs

White grubs are major pest of potato in hilly regions where its damaging stage (grub) coincides with the potato cultivation. The adult beetles start coming out of soil at dusk soon after pre monsoon showers generally in May end or early June and settle on nearby trees namely *Acacia* spp., roses, peach, plum, pear, apricot, apple (in hills) and neem tree (in plains) for mating and feeding. Only grubs are the damaging stage and its second and third instar grub feeds on the underground parts of plant such as roots and rootlets, making shallow and circular holes in the tubers (Fig. 9).



Fig. 9. White grub damaged tubers

Two to three deep ploughing before planting and soon after harvest helps to expose the resting stages to birds and other natural enemies. Potato suffers heavy losses in fields that previously had pasture or grasses. FYM applied in the field should be properly decomposed as raw FYM serve as food for the initial instars of white grub. The host trees (*Rubinia*, *Polygonum*, Kaithe and temperate fruit crops) of adult beetles should be pruned. Application of entomopathogenic fungus, *Metarrhizium anisopliae* @ 5 gm per lit of water. Apply two doses of Chlorpyrifos 20 EC @ 1100-1200 ml/ha. First dose should be applied at the time of planting over the raised bed and second at the time of earthing-up.

Potato cyst nematodes (PCNs) (*Globodera* species)

PCNs viz., *Globodera rostochiensis* (Woll.) and *G. pallida* (Stone) also popularly called the Golden nematodes, have a remarkable ability to survive for extended periods in soil without a host. Wherever they occur, stringent quarantine and regulatory procedures are imposed on them. Small patches of poorly grown yellowish plants appear in the field when the infestation is heavy and localised. Heavily attacked plants remain severely stunted with dull and unhealthy-looking foliage. As the season advances, the lower leaves turn yellow, brown, and wither, leaving only the young leaves at the top, the entire plant now presenting a somewhat 'tufted head' appearance. The browning and withering of the foliage gradually extend and ultimately cause the premature death of the plant (Fig. 10). The root



Fig. 10. Potato cyst nematodes infected field



Fig. 11. Infection of *Globodera* species; yellow females of *G. rostochiensis* (left) and white of *G. pallida* (right)

system is poorly developed, and the yield and size of the tubers are reduced considerably depending on the degree of infestation. Close examination of the roots of infected plants revealed the presence of small pinhead-sized, white (*G. pallida*) or yellow (*G. rostochiensis*) female nematodes sticking to the roots (Fig. 11).

Management

- To prevent the further spread of PCN to new areas, it is essential to restrict the movement of seed material from PCN-infested areas and use only certified, disease-free seeds.
- Crop rotation is also a key strategy to reduce the cyst population. A crop rotation of three to four years involving potatoes, French beans, peas, radish, cabbage, cauliflower, turnip, garlic, and green manure crops like lupin, can effectively reduce the cyst population.
- Four-year crop rotation following the Oat-Mustard-Mustard-Trap cropping

sequence resulted in the maximum reduction (74.3%) of the cyst population. Mustard-Rajmash-Trap-Rajmash (73.5%) and Potato-Oat-Trap-Mustard (55.9%) crop rotations were also found to be effective in reducing the cyst population in Kufri, Himachal Pradesh.

- Intercropping with French beans (3:2), mustard (1:1), and radish (2:1) has also been found to be effective in decreasing the cyst population while also increasing yields.
- Using susceptible potato cultivars such as Kufri Jyoti as trap crops can also help reduce the cyst population, but it is important to destroy the trap crops before the completion of the PCN life cycle (within 30-35 days after planting). Additionally, wild trap plant *Solanum sisymbriifolium* (a non-tuber plant) is one of the most promising trap crops for both species of PCNs.
- PCN-resistant potato cultivars like Kufri Swarna, Kufri

Neelima, Kufri Sahyadri, and Kufri Karan can be used to achieve good yields.

- To decontaminate freshly harvested seed tubers infested with PCNs, soak them in a 2% solution of sodium hypochlorite (NaOCl) for 30 minutes. However, tubers should be rinsed properly in running water immediately after the treatment and tubers should be dried properly under shade before storage.
- The use of Carbofuran 3G at the time of planting has been recommended for managing cyst nematodes. However, these chemicals have been banned recently. Instead, Carbofuran 3% CG (Furadan 3G) encapsulated formulation may be used as per the Insecticides Act, 1968, as of 1st June 2023.
- Soil fumigation with Methyl bromide (MBr) @ 400 lbs per acre is another option for decreasing cyst populations. However, a single application may not be sufficient to manage the PCN from the infested soil, so repeated applications may be necessary.
- Biological control agents such as *Pseudomonas fluorescens* and *Paecilomyces lilacinus*, as well as organic amendments like neem cake (5 t/ha) blended with *Trichoderma viride* (5 kg/ha), and incorporation of radish leaves at a rate of 1 kg/m² and covering with a polyethylene sheet are also known to suppress PCN population in soil.

Root knot nematode (RKN) (*Meloidogyne* spp.)

Root-knot nematodes (RKN) such as *Meloidogyne* spp. can cause significant crop loss worldwide in both warm and cool climatic conditions. In India, *M. incognita* is the dominant RKN species affecting potato in both hills and plains, while

M. javanica is found in mid-hills and plains of northern India. *M. hapla* is confined to hilly tracts of Uttar Pradesh, Himachal Pradesh, Jammu and Kashmir, and Tamil Nadu. However, *M. arenaria* is reported to be present in the plains of Uttar Pradesh. Root-knot nematodes infect many important crops such as cereals, pulses, vegetables, fruits, and ornamental plants. This makes them difficult to manage because they can always survive and reproduce on other host crops, including weeds.

The symptoms of RKN infection above ground include stunted and yellowing plants with chlorotic leaves due to the hindrance in water and nutrient uptake in roots. In roots, the characteristic swellings called “galls” are formed. The galls on the root are small and often unnoticed, but the warty “pimple-like” blemishes on the tubers due to nematode infection reduce the commercial value and keeping quality of potato tubers (Fig. 12). Brown spots are evident in the flesh of the cut tubers due to the presence of nematodes.



Fig. 12. Potato tubers infested with root-knot nematode (*Meloidogyne* spp.)

Management

- It is recommended to avoid using seed tubers from infected areas and instead plant nematode-free tubers.
- Deep ploughing during the summer months can also help in reducing the nematode population.

- Good sanitation practices and keeping the field free of weeds are also important.
- In addition, crop rotation with non-host crops like maize or wheat can minimize the damage caused by nematodes.
- Growing antagonistic crops such as marigold (*Tagetes patula*) in alternate rows with potatoes can also help reduce the population of root-knot nematodes in soil.
- Nematicides such as fluopyram (Velum Prime), fluensulfone (Nimitz), ethoprop (Mocap), and ethoprophos (Nimayuk) are recommended for the management of root knot nematodes.

CONCLUSION

Insect vectors have huge impact on virus free potato seed production. With proper understanding of the seed plot technique and using a recommended spray schedule, virus free potato seed can be grown in Indo-Gangetic plains during winter season. To manage PCNs in the northern-western and southern hills of India, ICAR-CPRI has released two new varieties, Kufri Shayadri and Kufri Karan. Additionally, ICAR-CPRI has developed a seed treatment protocol to treat freshly harvested PCNs infested seed tubers. Based on this protocol, the institute requested the government of India to relax domestic quarantine in Uttarakhand, Himachal Pradesh, and Jammu and Kashmir states. This request was approved by the Ministry of Agriculture and Farmers Welfare, Government of India on March 6, 2024. Now the seed production chain will start in Uttarakhand, Himachal Pradesh, and Jammu and Kashmir hilly states again, which were stopped due to PCNs.

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Know Krishi Unnati Yojana

The *Krishi Unnati Yojana*, a central sector scheme, is envisaged as umbrella programme for focusing on food security, by merging schemes on Soil-health Card, Integrated Scheme on Agricultural Co-operation and Agricultural Marketing, National Mission on Agriculture Extension, Horticulture Development, Price Stabilization Fund, National Mission on Sustainable Agriculture and other programmes.