

EPPO Datasheet: *Comovirus andesense*

Last updated: 2023-02-08

IDENTITY

Preferred name: *Comovirus andesense*

Taxonomic position: Viruses and viroids: Riboviria: Orthornavirae:

Pisuviricota: Pisoniviricetes: Picornavirales: Secoviridae

Other scientific names: *APMoV*, *Andean potato mottle comovirus*, *Andean potato mottle virus*, *Potato Andean mottle comovirus*, *Potato Andean mottle virus*

Common names: Andean mottle of potato

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EPPO Categorization: A1 list

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EU Categorization: Quarantine pest ((EU) 2019/2072 Annex II A)

EPPO Code: APMOV0

Notes on taxonomy and nomenclature

Different strains of Andean potato mottle virus (APMoV) have been described infecting potato (*Solanum tuberosum*): Lm the type strain in Peru (Fribourg *et al.*, 1977; Adams *et al.*, 2019), strains C and H (Salazar & Harrison, 1978) and B in Brazil (Avila *et al.*, 1984). Strains Lm and C cannot be differentiated from each other using serological tests (Salazar & Harrison, 1978); Schroeder & Weidemann, 1990) but are serologically different to B and H. Strains B, C and H differ from the type strain in symptomatology and host range. New APMoV variants, as yet uncharacterized but possibly representing new strains, have been detected in Peru using high throughput sequencing (Fuentes *et al.*, 2019; Kreuze *et al.*, 2019).

Although a virus isolated from tabasco pepper (*Capsicum frutescens*) from Honduras and Nicaragua was reported as a new serotype of APMoV 'the pepper strain of APMoV' (Valverde *et al.*, 1995), sequence analyses of the protein domains, proteinase and RNA polymerase (Pro-Pol) of RNA1 and coat protein (CP) of RNA2 suggested that this was a new virus species since amino acid (aa) percentage identity was below 73% in the combined CP region and below 80% in the Pro-Pol region, which are assumed to be the species threshold for comoviruses (Alcalá?Briseño *et al.*, 2019). The name, pepper mild mosaic virus was proposed. Although this new virus species has not yet been approved by the International Committee on the Taxonomy of Viruses (ICTV, 2022a) it is not considered in this datasheet as strain of APMoV. Additionally, Adams *et al.* (2019) has indicated that APMoV strain B (Krengiel *et al.*, 1993; Shindo *et al.*, 1993) may be a new virus species because of only 68% aa identity for the combined coat protein (partial sequence) between this strain and the type strain, but further studies were required because the 94% aa identity in the Pro-Pol region (partial sequence) did not meet the criteria for a new species. Analysis of recently published full sequence data for RNA2 and RNA1 of the Brazilian strain (GenBank accession numbers QYA72454 and QYA72453) shows similar results to those of Adams *et al.* (2019) with 74% and 93% aa identity to the Lm strain. Because of the need for further investigations, including the sequencing of more strain isolates, this datasheet includes the Brazilian strain B as a strain of APMoV.

HOSTS

APMoV has a narrow host range. The major host of APMoV is potato (*Solanum tuberosum*) and other tuber forming *Solanum* species such as *S. chaucha* and *S. stenotomum*. In Argentina, it was detected in native *S. tuberosum* subsp. *andigenum* potato cultivars (Azul, Blanca redonda, Collareja and Ojosa) and *S. curtilobum* (cv. Luqui) (Clausen *et al.*, 2005). It has also been recorded in Brazil, infecting *Solanum aethiopicum* (Ethiopian or scarlet eggplant) (Kitajima *et al.*, 1984) and *Solanum sisymbriifolium* (Souza-Dias *et al.*, 1994) although this isolate of APMoV was unable to infect *Datura stramonium* and local cultivars of potato following mechanical inoculation. An APMoV strain similar to strain C has also been isolated from aubergine (*S. melongena*) (Brioso *et al.*, 1993).

Other *Solanum* (Fribourg *et al.*, 1977) and solanaceous species have been infected under experimental conditions. Some strains can also be transmitted to *Gomphrena globosa* (Amaranthaceae) and *Tetragonia tetragonoides* (Aizoaceae) (Salazar & Harrison, 1978).

Host list: *Solanum aethiopicum*, *Solanum chaucha*, *Solanum curtilobum*, *Solanum melongena*, *Solanum sisymbriifolium*, *Solanum stenotomum*, *Solanum tuberosum* subsp. *andigenum*, *Solanum tuberosum*

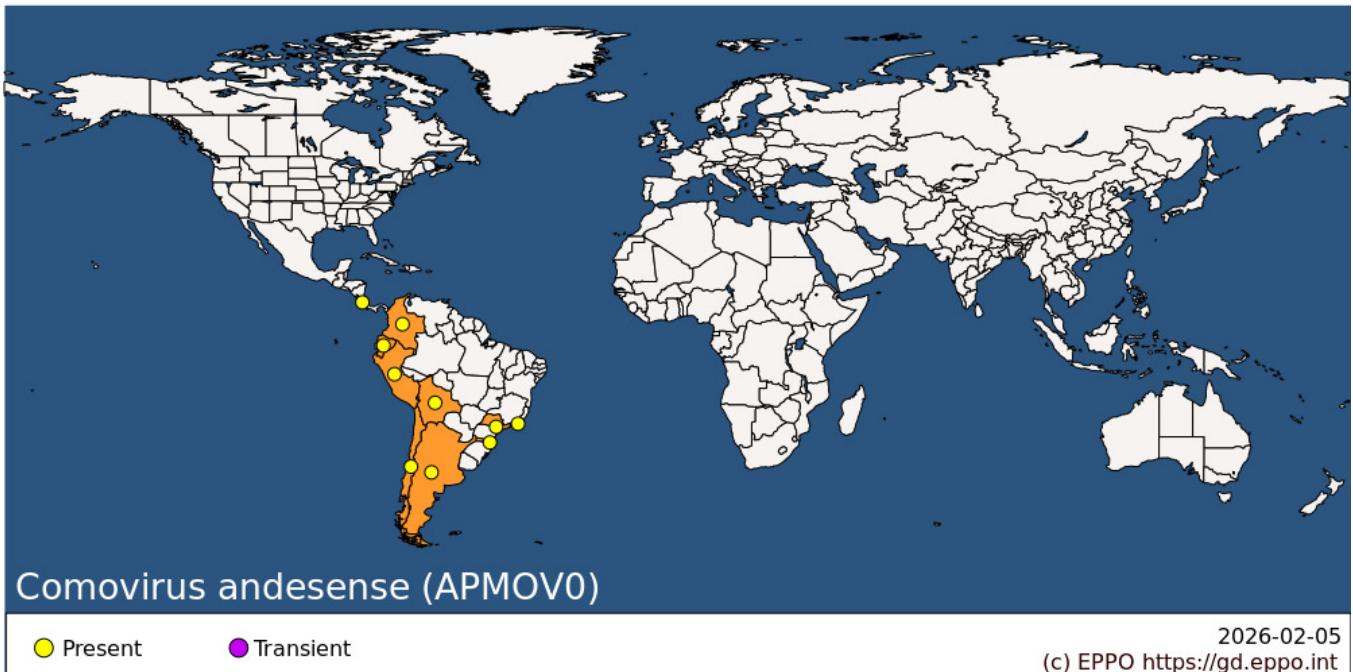
GEOGRAPHICAL DISTRIBUTION

APMoV is thought to occur throughout the Andean region at altitudes of 2000-4000 m (Fribourg & Jones, 1981), but it also occurs at altitudes less than 1800 m, as in Costa Rica (Vásquez *et al.*, 2006). Based on past ELISA survey results for the virus species *Andean potato latent virus* (APLV), APMoV, *Potato leafroll virus* (PLRV), *Potato virus S* (PVS), *Potato virus X* (PVX) and *Potato virus Y* (PVY), APMoV was found to be the 3rd most frequently detected virus, behind PVX (37-82%) and PVS (19-53%), in the period 1985-87, in the Peruvian highlands (>2900 m above sea level, masl). It was found at 3-13% incidence in leaf samples taken from farmer's fields, although the *S. tuberosum* hybrid cv. Yungay was found to be infected at incidences of 30% and 60% in the Valley del Mantara, and Cusco areas, respectively (Bertschinger *et al.*, 1990). Similar virus incidences since the 1980s were also reported by Kreuze *et al.* (2020) for PVX (30-82%), PVS (20-50%) and APMoV (4-15%). Now however, Peruvian potato growers no longer find APMoV to be a problem because routine inspection and testing has enabled its elimination from many potato fields (L Salazar, formerly CIP, Peru, personal communication, 2022). Indeed, in a recent survey using high throughput sequencing (HTS), mostly conducted in the Peruvian Andean region (2545-4268 masl) but also in the coastal departments of Ica and Lima (70 – 470 masl), which receive seed from the Andean regions, APMoV (including potentially new strains) was found to be the 7th most commonly found virus, at 8% incidence. More frequently found viruses (not including potentially new virus strain or species) were PVX (55%), PVY (34%), *Potato virus V* (19%), *Potato virus B* (18%), PVS (13%) and *Potato virus A* (12%) (Fuentes *et al.*, 2019; Kreuze *et al*., 2019). Additionally, potentially new comoviruses were found in 8% of samples, indicating the wide range of virus diversity in the Andean region.

In Argentina, in 2001, APMoV was detected in 4% of potato accessions (comprising *Solanum curtilobum* and *S. tuberosum* subsp. *andigenum* cultivars) on farms located 3600-4000 masl in the Andean Jujuy province, departments Humahuaca, Santa Catalina, Susques and Tumbaya.

In Bolivia, in 1992, APMoV was amongst the four most frequently detected viruses in *S. tuberosum* subsp. *andigenum* cv. Huaycha in the Cochabamba Andes region (2900–3380 masl) (reported in Coco Morante *et al.*, 2021). Since then, in Cochabamba, it has not been detected in the Aymara region and only at incidences of 4% in the Quechua region leading the authors to conclude that the virus might be losing its importance in the Andean region (Coco Morante *et al.*, 2021).

In Chile, although APMoV has been reported infecting potato (Contreras & Banse, 1982), it was not reported following testing of 98 samples collected from the Chiloé Archipelago using HTS (Pena Reyes, 2019).



Central America and Caribbean: Costa Rica

South America: Argentina, Bolivia, Brazil (Rio de Janeiro, Santa Catarina, Sao Paulo), Chile, Colombia, Ecuador, Peru

BIOLOGY

APMoV belongs to the genus *Comovirus*, members of which are typically beetle-transmitted, especially by members of the family Chrysomelidae. Transmission occurs immediately upon initiation of feeding, although higher frequencies of transmission occur with prolonged feeding and with beetles retaining their ability to transmit the virus from a few days to weeks (Gergerich & Scott, 1996; ICTV, 2012). The beetles normally have a very narrow host range (Fulton *et al.*, 1987). *Diabrotica* spp. (Coleoptera: Chrysomelidae) are prevalent in regions where the virus is found (Avila *et al.*, 1984) and APMoV has been reported by Abad and Salazar (unpublished) in Avila *et al.* (1984) to be transmitted by *Diabrotica viridula* and *Diabrotica* spp. in glasshouse experiments (Salazar, 1996). However, transmission of APMoV by an *Epitrix* sp. (Coleoptera: Chrysomelidae) was unsuccessful (Fribourg *et al.*, 1977). APMoV is also readily transmitted mechanically and by contact between plants. Although seed transmission has been reported for other comoviruses (ICTV, 2012), APMoV is not known to be transmitted by true seed (Fribourg *et al.*, 1979).

DETECTION AND IDENTIFICATION

Symptoms

At temperatures of 16-20°C, primary infection by APMoV in most Peruvian potato cultivars, induces a mild, patchy leaf mottle; but some sensitive cultivars may react with systemic top necrosis followed by strong mottle, leaf deformation and stunting of new growth. Secondary symptoms are strong mottle, leaf deformation and stunting. No tuber symptoms have been reported, but the virus may induce delayed emergence of sprouts (Fribourg *et al.*, 1977; Fribourg & Jones, 1981; Jones *et al.*, 1982). Under cool conditions, plants may develop yellow spotting, blotching or more generalized yellowing on leaves (Fribourg *et al.*, 1979).

The virus caused leaf mottle in *Solanum aethiopicum* (Kitajima *et al.*, 1984) and *S. melongena* (Brioso *et al.*, 1993) and in *Solanum sisymbriifolium* severe leaf mosaic (Souza-Dias *et al.*, 1994) and leaf distortion.

Morphology

APMoV virions are isometric, non-enveloped and of two types each of about 28 nm in diameter and exhibit icosahedral symmetry ($T = 1$, pseudo $T = 3$) (ICTV (2022b)). The genome is bipartite and consists of two positive-sense single stranded RNA molecules, designated RNA1 of 6038 – 6093 bases and RNA2 with 3439 – 3767 bases, separately encapsulated into isometric particles, composed of two coat proteins of 42 kDa and 22 kDa (Shindo *et al.*, 1992, ICTV 2022c). The complete coding sequence of the type strain Lm (Adams *et al.*, 2019) and other APMoV strains has been obtained (see <https://www.ncbi.nlm.nih.gov/nuccore/?term=andean+potato+mottle+virus>).

Detection and inspection methods

Field inspection of potato plants and other host plants may enable detection of the virus (see section on Symptoms); EPPO Standard PM 3/71 General crop inspection procedure for potatoes (EPPO, 2007). APMoV is reliably detected in *in vitro* plants (4–6 weeks old and with stems of at least 5 cm) and plants grown from infected tubers using indicator plants and serological and molecular methods. The reliability of testing tubers has not been reported.

Indicator plants

Indicator plants for use in quarantine testing are listed in PM 3/21 *Post-entry quarantine for potato* (EPPO, 2019a). Recommended indicator plants are: *Nicotiana bigelovii* (symptoms of mosaic characterized by dark-green blotches and sometimes necrotic areas); *N. clevelandii* (similar symptoms but no necrosis) (Fribourg *et al.*, 1977); *N. occidentalis* P1 (local necrosis/wilting and necrotic lesions followed by systemic chlorosis and dwarfing) (Verhoeven & Roenhorst, 2000).

Serological detection methods

High-titre antisera can be prepared for use in ELISA and polyclonal antibodies are available commercially. ELISA variations, including dot-ELISA on nitrocellulose membranes, are also well suited especially for large-scale routine use (Dusi & Avila, 1988; CIP, 1989). Although the APMoV strains Lm and C are serologically different to B and H this is unlikely to affect detection, with polyclonal antibodies raised to each strain detecting all strains using double-antibody sandwich ELISA (Schroeder & Weidemann, 1990).

Molecular methods

One-step RT-PCR using the forward and reverse primers Como1F and Como1R for detection of comoviruses may be used followed by sequencing the PCR amplicon (~434 bp) for confirmation of virus identity. The primers were designed using an alignment of RNA-1 sequences from 10 comovirus species available in the GenBank database, including APMoV (Perez-Egusquiza *et al.*, 2014). For specific identification without sequencing APMoV nested primer sets 20 and 37 (which produce 128 bp and 391 bp APMoV specific amplicons) (Lee & Rho, 2015) may also be suitable for use.

PATHWAYS FOR MOVEMENT

Plants for planting of Solanaceous hosts (including potato tubers) moved locally or internationally constitute the major pathway for movement of APMoV. Viruliferous vectors (*Diabrotica* spp.) hitchhiking on imported products such as aubergine may also constitute a pathway if they are able to retain and transmit the virus for several weeks and escape at import and establish in the field. Worldwide, increasing interest is being shown in Andean root crops and these are often grown in association with, or in the same area as potato. Although they have been shown to be infected with other Andean viruses, they have not yet been shown to be infected with APMoV.

PEST SIGNIFICANCE

Economic impact

APMoV usually causes symptoms in potato crops, which may be severe in sensitive potato cultivars. It is considered

to be widespread and economically damaging in areas where it occurs, although the direct effects on yield do not appear to have been studied. Furthermore EFSA (2020) considered that any foliar symptoms were likely to affect photosynthesis, and thus yield and/or quality of tubers, but were unable to quantify the magnitude of the effect under conditions in the EPPO region. Similarly, the effect of APMoV on the yield and therefore economic impact on other hosts such as *Solanum aethiopicum* and *Solanum melongena* is unknown. In the EPPO region, the only place where *S. aethiopicum* appears to be grown to a significant extent is South Italy (Anon, 2022). *Solanum melongena* is widely grown (FAO, 2022).

Additionally, if APMoV were to be introduced into a country and then established, export of potatoes to countries where it was regulated as a quarantine pest would be affected resulting in further economic loss.

Control

For potato, control depends on the production of high-quality planting material from virus-free nuclear stock and production of certified potatoes in a pest free area or a pest-free production system according to PM 3/61 *Pest-free areas and pest-free production and distribution systems for quarantine pests of potato* (EPPO, 2019b) with appropriate measures to minimize mechanical transmission. Although the wild stolon forming but non-potato tuber forming species *Solanum palustre* (formerly *S. brevidens*) and *S. etuberosum* have been reported as resistant to APMoV, opening the possibility for resistance breeding (Valkonen *et al.*, 1992) there are obstacles in incorporating this resistance into conventional potato breeding programmes. This is because these *Solanum* species are difficult to cross sexually with cultivated potato. Instead, protoplast fusion with tetraploid potatoes is required in order to create a hexaploid, which can then be used in breeding programmes.

Phytosanitary risk

Climatic conditions will not impair the ability of APMoV to establish in the EPPO region. Potato is widely grown and is the main crop at risk along with *Solanum melongena*. Although EFSA (2020) concluded that APMoV met the criteria to qualify as an EU quarantine pest, the magnitude of potential impact in the EU was unclear.

PHYTOSANITARY MEASURES

EPPO recommends its member countries to prohibit the import of all breeding material of potato, of whatever origin, except under a special permit, subject to post?entry quarantine (EPPO, 2017; 2019a; 2022). Once tested and found to be free from pests it may be released from quarantine and moved within the EPPO region.

Certified seed potatoes (micropropagative material and minitubers) may be traded if they meet the requirements of EPPO Standards PM 3/62 *Production of pathogen-free microplants of potato* (EPPO, 2019c) and PM 3/63 *Production of pathogen-free minitubers of potato* (EPPO 2019d) respectively. For import of seed potatoes and ware potatoes, EPPO recommends that trade should be subject to transitional arrangements described in PM 8/1 *Commodity-specific phytosanitary measures for potato* (EPPO, 2017), which requires for countries where APMoV occurs, import from a pest-free area and from a pest-free potato production and distribution system, according to EPPO Standard PM 3/61 *Pest-free areas and pest-free production and distribution systems for quarantine pests of potato* (EPPO, 2019b). Additionally, for countries in Central and South America where APMoV does not occur, recommendations are confirmation by detection survey that APMoV does not occur and inspection or testing of tubers on import.

Additionally import of potato is regulated/prohibited in many EPPO countries. In the EU, the import of seed potatoes and plants for planting of stolon-or tuber-forming species of *Solanum* or their hybrids is prohibited from third countries, other than Switzerland, by Annex VI of Commission Implementing Regulation (EU) 2019/2072 (EU 2022). Entry of ware potatoes is also regulated, and import is only permitted from specified countries, which currently does not include countries in Central and South America where APMoV is known to be present. However as long as ware potatoes are not planted and only used for consumption or processing, the ability of APMoV to establish is likely very low (EFSA, 2020).

Also, it should be noted that import of plants for planting of other potential Solanaceae hosts of APMoV, such as *Solanum aethiopicum*

and *S. melongena* other than seeds (APMoV is not known to be seed transmitted), are prohibited in many EPPO countries, as is the case in the EU (EU, 2022).

The pathway of viruliferous vectors (*Diabrotica* spp.) hitchhiking on imported products such as aubergine is possibly open and the existence of possible vectors in the EU is unknown (EFSA, 2020).

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ACKNOWLEDGEMENTS

This datasheet was extensively revised in 2023 by C Jeffries (SASA, UK) with help from J Kreuze (CIP, Peru), L Salazar (formerly CIP, Peru) and J Souza-Dias (IAC, Brazil). Their valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2026) *Comovirus andesense*. EPPO datasheets on pests recommended for regulation. Available online. <https://gd.eppo.int>

Datasheet history

This datasheet was first published in the EPPO Bulletin in 1984 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2023. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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Co-funded by the
European Union