

Reconsidering the complex nature of PVY strain nomenclature

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“For the viroses [viruses] of no other plant is the necessity of a logical and internationally understandable classification more urgent than for those of the potato plant”

H.M. Quanjer, 1931

Background

Several virologists working with potato virus Y (PVY) have recently expressed concerns about the proliferation of strain acronyms as evidenced at the 12th EAPR Virology Section Meeting in Rennes, France in 2004 with a ‘Round table on terminology in PVY’. After an inconclusive discussion, it was suggested that a committee would look into this matter and suggest a new nomenclature for PVY strains at the 13th EAPR Virology Section Meeting. Since PVY nomenclature started in Europe by using alphabet X and Y to designate individual viruses of the mosaic complex, it became a tradition continuing even today. Reviewing early literature the terminology assigned to viruses and their strains were arbitrary, without any justification, and done more as a convenience than for purpose. Despite cases of the same acronym being used for two different strains of PVY, there is no mention of any inconvenience and or criticism. The most prevalent PVY strain was termed “old”, “normal” , and/or “common” but the acronym adopted was

O or PVY^O, while the necrotic strain was identified as N or PVY^N. Many terms have been coined to the new variants of PVY^N sub-group within a short duration of their discovery. In some cases, the geographical distribution and molecular characterization of the isolates were incomplete, thus creating some confusion. New terminology for these variants is sought in this discussion.

The early nomenclature of potato viruses

Plant virology was at its infancy at the turn of the 20th century, with rapid progress in potato virology during the years 1910-1931. Disease symptoms were the driving force in identifying “new” virus- diseases in potatoes. The individual virus entity was unknown and could not be associated with the disease. For example, leaf roll disease was described as “a trouble of unknown nature, probably non-parasitic, characterized by an upward rolling of leaves, a decrease in yield of tubers and by hereditary transmission of the disease condition” (Worton 1913). A decade later, Quanjier (1924) attempted to standardize the ‘degeneration disease’ complex by growing “pure cultures of diseases” in differing potato varieties and observing the overlapping symptoms. He showed that a *common* mosaic could change to an *interveinal* mosaic, to a *marginal* mosaic, to a *crinkle* and finally to a *stipple* mosaic depending on the variety. He concluded that “diagnosing a given potato virus disease with certainty is possible in most cases, only when we transfer it to one or more potato varieties whose behaviour towards all of these diseases is well-known”. This probably was an earliest implication of a differential host concept to indirectly “assign” the causal agents in potato diseases. However, there were many calls for the standardization of virus names for potatoes. A suggestion was made for “an

authorized scientific committee for the selection of satisfactory descriptions and their standard designation by number in separate Series for each species of host plant, or in a single Series” (Folsom, 1927). An example given by Folsom (1927), shows that a potato virus would be initially described as: “*Solanum tuberosum* L., virosis 1. Described as *rugose mosaic* by E.S. Schulz and Donald Folsom in Jour. Agr. Res. 25: 52-53. 61:1923. Synonym *crinkle* as described by Paul A. Murphy in Canada Exp. Farms Div. Bot. Bul. 44, II. 71-74. 1921. Identical with *Nicotiana tabacum* L. virosis 5, and *Lycopersicon esculentum* Mill. virosis 2.”

By the late 1920s, the method of ‘needle inoculation’ and use of ‘filter hosts’ were introduced for potato virus diseases to dissect the mosaic complex. Although, simultaneously two groups of American researchers (Koch, 1931; Valleau and Johnson, 1931) independently had determined the constituents of *rugose* mosaic complex as an ‘aphid-transmitted’ and a ‘mottle’ virus, the credit to the nomenclature of potato viruses designated as single alphabet, goes to K.M. Smith (1931). The following sentence appeared in his 1931 paper, “the constituent viruses of which, for the sake of clarity, will be referred to as *X* and *Y* where *X* represents the virus which forms in tobacco double concentric rings with a central spot, hereinafter referred to as ‘ringspot’, and *Y* represents the aphis-borne virus, the symptoms of which take the form of a darkening of the green colour of the tissues along the veins”. This report essentially set the precedence of the nomenclature of potato viruses using single alphabet. For example, a year later, Murphy and McKay (1932) discerned the complex nature of *crinkle* mosaic disease and named the unknown constituent as disease A, the virus as virus A and the other constituent as the ‘simple mosaic’ virus.

Within a decade other letters of the alphabet were used for designation of potato viruses inducing different symptoms in potato cultivars. For example, *aucuba* mosaic became virus G (Clinch et al., 1936), the *streak* disease in cultivar UpToDate as Virus B, *foliar necrosis* disease as Virus D (Dennis, 1937) and the *pseudo-net necrosis* or *tuber blotch* disease as Virus F (Clinch et al., 1936). This trend continued into mid 1950s, when one constituent of the '*interveinal* mosaic or *crinkle* virus was designated as "virus M" (Bagnall et al., 1956) and it was shown that the viruses described earlier as virus E (Dykstra, 1939) and virus K (Köhler, 1942) were in fact virus M. Soon another virus belonging to Virus M group was named 'virus S' (Rozendaal and Van Slogteren, 1958).

The intriguing nature of the nomenclature of PVY strains

The virus, forerunner of the alphabetized nomenclature was subjected to a second wave of alphabetized superscript nomenclature of its strains unparalleled in the history of virology. In the 1950's a new variant of PVY was spreading in many countries of Europe and was referred to by various names. The earlier described PVY strain, causing severe symptoms in potato and mild symptoms in tobacco was referred to as 'virus Y' (Bawden and Kassanis, 1951), 'old' Y strain (Arenz and Hunnius, 1959), 'common' Y^O (De Bokx, 1961), and 'normal' Y^N (Horvath, 1963; Miczynski, 1963). A new variant of PVY causing veinal necrosis in tobacco leaves and mild mottle in most potatoes was called 'veinal necrosis virus' (Bawden and Kassanis, 1951), the tobacco vein browning strain (Arenz and Hunnius, 1959), "Rippenbräune" strain Y^R (Nienhaus, 1960), tobacco veinal Y^N (De Bokx, 1961), and 'necrotic' Y^R (Horvath, 1963; Miczynski, 1963). Interestingly, Keller and Münster (1961) designated Y^N to describe the veinal necrosis

strain, but cite the only reference in their paper of Nienhaus (1960), who used Y^N to refer the common strain of PVY. With the confusing state of PVY strain nomenclature in Europe, it is not surprising that when PVY^N was discovered in USA in two *Solanum* samples from Bolivia, the authors (Kahn and Monroe, 1963) tagged a descriptive name of tobacco vein necrosis strain of potato virus Y (PVY-TVN).

The molecular virology and PVY^N strain nomenclature

With the discovery of a variant of PVY^N , in several European countries (Beczner et al., 1984; Kus, 1995) and the emergence of PVY^N strains in North America (Singh, 1992; McDonald and Kristjansson, 1993) the stage was set for the third wave of nomenclature – this one based on molecular characterization. By this time partial and complete nucleotide sequences of viral RNA (Robaglia et al., 1989; Kerlan et al., 1999; Thole et al., 1993; Singh and Singh, 1996; McDonald et al., 1997; Jakab et al., 1997; Glais et al., 2002; Nie and Singh 2003, Nie et al., 2004) were becoming the normal tools of plant virology. As a result, pathological, morphological, geographical and now molecular features of a variant isolate were used in the nomenclature of PVY. For example, the PVY^N isolates inducing necrotic ringspot symptoms on tubers and having three recombination junctions were designated the acronym PVY^{NTN} (Le Romancer et al., 1994; Glais et al., 2002). The PVY^{NTN} isolate not detected by a primer set developed against PVY^{NTN} from Europe (Weidemann and Maiss, 1996) and containing no recombinant junction was referred to as North American PVY^{NTN} (Weilguny and Singh, 1998) or NA- PVY^{NTN} (Nie and Singh, 2002a). Findings of additional PVY^N variants, which serologically reacted with PVY^O specific antibodies but caused veinal necrotic symptoms in tobacco were termed PVY^N -Wi (Chrzanowska, 1991; Blanco-Urgoiti et al.,

199) and on the basis of nucleotide sequences of their recombinant RNA molecule, PVY^{N:O} (Nie and Singh, 2002b). A pathotype variant, previously named as PVY^Z (Jones, 1990) belongs to PVY^N on the basis of their specificity to a 5' end PVY^N specific primer, although they react serologically to PVY^O specific antibodies and do not cause vein necrosis symptoms in tobacco (Blanco-Urgoiti et al., 1998). However, "European"-type strain variants of PVY^N and PVY^{NTN} have been now discovered in North America (Lorenzen et al., 2006) and NA-PVY^{NTN} types have been found in Europe ().

Situational analysis

The foregoing review of potato virology literature, clearly shows that the alphabetical assignment of viral names were arbitrarily made and have created much confusion. They were intended to simplify the situation in the absence of information about the causal agent. However, it became precedence setting and unfortunately still continues today. It was quite confusing for potato virology researchers in the early days, as evidenced by several attempts to standardize the naming of potato viruses (Folsum, 1927, Quanjer, 1931). The situation became particularly acute, when the same acronym was being used for two different strains of PVY. For example, Y^N was used to designate 'normal' strain (Nienhaus, 1960), but also 'necrotic' strain (De Bokx, 1961); further confusion when the 'necrotic' strain was referenced using two acronyms: PVY^N (De Bokx, 1961) and PVY^R (Horvath, 1963; Miczynski, 1963). In spite of the advances in potato virology research, the complicated situations have not improved, as evidenced by the nomenclature of PVY^{N:O} based on the molecular composition (Nie and Singh ,

2002b) and PVY^NWi based on the first potato cultivar “Wilga” in which an necrotic isolate was found (Chrzanowska,1991).

Besides complicating the interpretation of virus researchers, the virus strain names could have serious implication in today’s export-market based agriculture. Quarantine regulation can be imposed if a virus strain name implicates differences of entity from the existing one in a nation’s list of viruses. Since one of the objectives of virus research is to increase the economic returns to the potato growers, the minor differences of two isolates should not be made a basis of new nomenclature.

Suggestions:

The virus or strain names are meant to provide some information about their symptoms, morphological features or some other property. Since alphabetical designations do not provide definitive information about viral symptoms, molecular structure or unique behaviour of the virus, it should be dropped in favour of descriptive individual virus names or groups of strains. Of course, any name would be contingent upon the amount of information known about a particular virus or its strain at the time of designation of a new name. To minimize the economic market driven loss of a particular strain name, along with symptom severity, aggressiveness, molecular properties, consideration should be made about its quarantine significance. From that perspective, the nomenclature of PVY^N could be limited to two strains non recombinant (0RJ) and recombinant (RJ) on the basis of molecular structure. The acronym should be separated as PVY^N /0RJ or PVY^N/1RJ or PVY^N/2RJ etc. For example, the isolates with the ability to cause tuber ringspot necrosis can be designated as PVY^{NTN} / 0RJ and so on.