African Crop Science Journal, Vol.1, No. 2, pp. 131–138, 1993

1021-9730/93 $ 10.00 + 0.00

INCIDENCE AND DISTRIBUTION OF POTATO VIRUSES IN PLATEAU STATE, NIGERIA

A.M. MIHA, H.W. ROSSEL[1] and G.I. ATIRI
Department of Agricultural Biology, University of Ibadan, Nigeria
[1]Virology Unit, International Institute of Tropical Agriculture,
P.M.B., 5320, Ibadan, Nigeria.

(*Received* 20 *September* 1993; *accepted* 4 *December* 1993)

ABSTRACT

Potato farms and backyard holdings in Plateau State were surveyed for potato viruses S,X,Y and leaf roll in 1990–1992. Random and biased field samples as well as leaves from sprouted seed tubers from local markets were tested for the four viruses by the enzyme-linked immunisebent assay (ELISA). The incidence of viruses in the fields in four districts was between 45 and 62%, although it reached 90.9% at Chisu in one occasion. Potato virus X (PVX) was the most prevalent while potato virus Y (PVY) and potato leaf roll virus (PLRV) were the least. Virus incidence in plants sprouting from seed tubers in the screen house was more or less comparable to field incidence. Mixed infections by viruses were common, those containing PVX being the most prevalent. PVY scarcely occurred in mixed infections with potato virus S or PLRV.

Key Words: **Nigeria, Plateau State, Potato viruses**

RÉSUMÉ

Des exploitations de pomme de terre et des jardins dans l'Etat de Plateau étaient examinés pour la présence des virus de pomme de terre S, X, Y et le "leaf roll". Des échantillons de champs élues au hasard et faussées, ainsi que des feuilles issues des tubercules germés obtenues des marchés locaux ont été testées pour ces quatre virus par la technique ELISA (enzyme-linked immunisebent assay). L'incidence des virus aux champs dans quatre districts était entre 45 et 62 %, bien qu'elle atteigne 90,9 % à Chisu dans un cas particulier. Le virus de pomme de terre X (PVX) était le plus fréquent, tandis que le virus de pomme de terre Y (PVY) et le "potato leaf roll virus" (PLRV) étaient les plus rares. L'incidence des virus dans les plantes issues des tubercules germés dans les serres était plus ou moins comparable à l'incidence aux champs. Des infections mixtes étaient courantes, celles avec le PVX étant les plus fréquentes. PVY se rencontrait assez rarement dans les infections mixtes avec le virus de pomme de terre S ou avec le PRLV.

Mots Clés: **L'Etat de Plateau, Nigéria, virus de pomme de terre**

INTRODUCTION

Potato, *Solanum tuberosum* L., was introduced into Nigeria in the 19th century, through missionary activities (Obigbesam, 1976). The production was encouraged by the British Government during the Second World War as tubers were needed to feed servicemen. Since then, the importance of potato has been widely realised such that it is now an important commodity of internal trade. Although production has increased by over 120% in the last 10 years (FAO, 1990), it is still grossly below demand. Apart from low quality seed and poor storage facilities, diseases are also a limiting factor to potato production in Nigeria (Ifenkwe and Suchomel, 1983).

Over 30 viruses and strains are known to infect potato in various potato growing areas (Salazar, 1990). The most important of these are found in four virus taxa, luteo-, poty-, potex- and carla- viruses, although viruses in other taxa may be of localized importance. Potato leaf roll luteovirus (PLRV) occurs world-wide causing disease in potato and tomato (Harrison, 1984). Potato A potyvirus (PVA) is also of world-wide occurrence and has been found to cause crinkle disease in mixed infection with potato X potexvirus in Malawi (Lyon and Pergrine, 1974). Potato V potyvirus (PVV) is more restricted in its spread (Jones and Fuller, 1984) while potato Y potyvirus (PVY) is the most widespread (De Bok and Huttinga, 1981). In Africa, PVY has been reported in potato from Kenya (Ngugi, 1983) and Ethiopia (Yusuf, 1970). It also infects pepper and tobacco in Morocco (Lockhart and Fischer, 1974, 1976a and 1976b). Potato X potexvirus (PVX) is a contact-transmitted virus that occurs worldwide (Berk, 1970). It has been found to completely infect seed stocks in Australia (Wilson and Jones, 1990). Potato S carlavirus (PVS) causes inconspicuous or symptomless infections in most potato clones that can translate into yield losses of up to 20% (Wetter, 1971). It is also widespread and may occur in mixed infections with potato M carlavirus or some other potato viruses, causing a more severe diseases.

There are concerted efforts to expand potato production in Nigeria. The irish potato programme of the National Root Crop Institute (NRCRI) in collaboration with the International Potato Center (CIP), Peru, in recent times imported a lot of breeding materials and some high yielding potato clones. This has necessitated an assessment of the virus situation in Nigeria since the information is needed in establishing the presence of viruses and setting priorities for breeding programmes and recommending appropriate control measures. The results of the survey are hereby reported.

MATERIALS AND METHODS

Disease surveys. The survey and sampling was conducted on farmers' fields during two dry season irrigated crops and one rain-fed crop between 1990 and 1992. The producing area which falls within the northern agroecological zone of the Plateau Agricultural Development Programme (PADP) was split into four blocks (Fig. 1) based on accessibility and availability of temporary storage facilities. Leaf samples from field-grown plants were collected at about flowering, when the plants were 6–8 weeks old. In commercial fields (0.25-1.5 ha) samples were collected irrespective of symptoms along a single diagonal at about 40 km intervals. Additional biased samples based on symptom type were collected outside the diagonal to take care of viruses that may occur at a very low incidence. Sampling in backyard holdings (less than 0.25 ha) was based on symptom type only. Each sample consisted of three single leaflets taken from the top, middle and bottom of the foliage, and placed in a polythene sample bag. Samples were appropriately labelled to indicate the sample number, cultivar name, location and date of collection. Additional information collected for each field included the age of the crop, the preceeding crop and the cropping system. Samples were temporarily stored in a domestic refrigerator before being transported to the laboratory in Ibadan in an ice chest.

Seed tubers were purchased from local markets in Bokkos and Barakin Ladi during the late planting season (October) of 1991. Small quantities of 20–30 tubers from various seed consignments were bulked for each locality. Tubers were allowed to grow in wooden boxes containing steam-pasteurized garden soil in the screenhouse. Twenty-five planting, single leaflets were taken and tested for the presence of viruses.

Serological testing. All samples were tested for potato viruses S,X,Y and leaf roll in duplicate wells of polystyrene microtitre plates by either of two ELISA protocols. The direct double antibody sandwich (DAS) ELISA was performed by the method of Clarke and Adams (1977) using antibodies and alkaline phosphatase enzyme conjugates supplied by Dr. L.F. Salazar of CIP, Peru. A sample was considered positive for each virus when the absorbance at 405 nm was at least twice that of the healthy control.

The indirect antigen-coated plate (ACP) ELISA was performed by the method of Singh and Barker (1991) using goat anti-rabbit IgG penicillinase enzyme conjugate as the detecting antibody. Antivirus antibodies for use here were obtained from Dr. H. Barker of Scottish Crop Research Institute, Invergowire, Dundee, and Dr. A.F.L.M. Darbs of the Laboratrium Voor Bloembollenonderzock, Bulb Research Center, The Netherlands. A sample was considered positive for a virus when the absorbance at 630 nm was at most half that of the healthy control. In each case, samples containing the viruses under test were included as positive controls.

RESULTS

Virus and virus like symptoms were observed in the fields during the survey. These included yellow and rugose mosaics, mild mottle and leaf roll

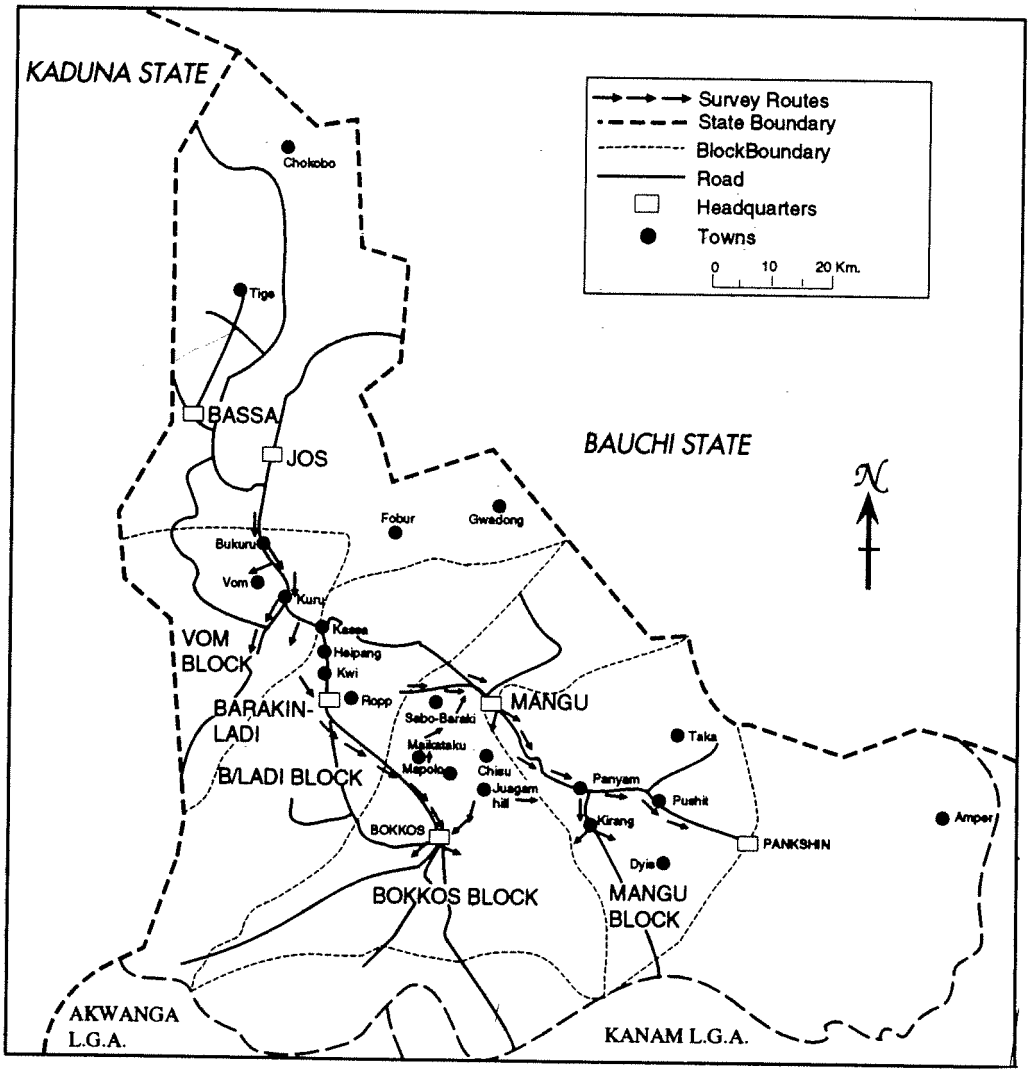

Figure 1. Study site showing survey routes and blocks in Plateau State, Nigeria.

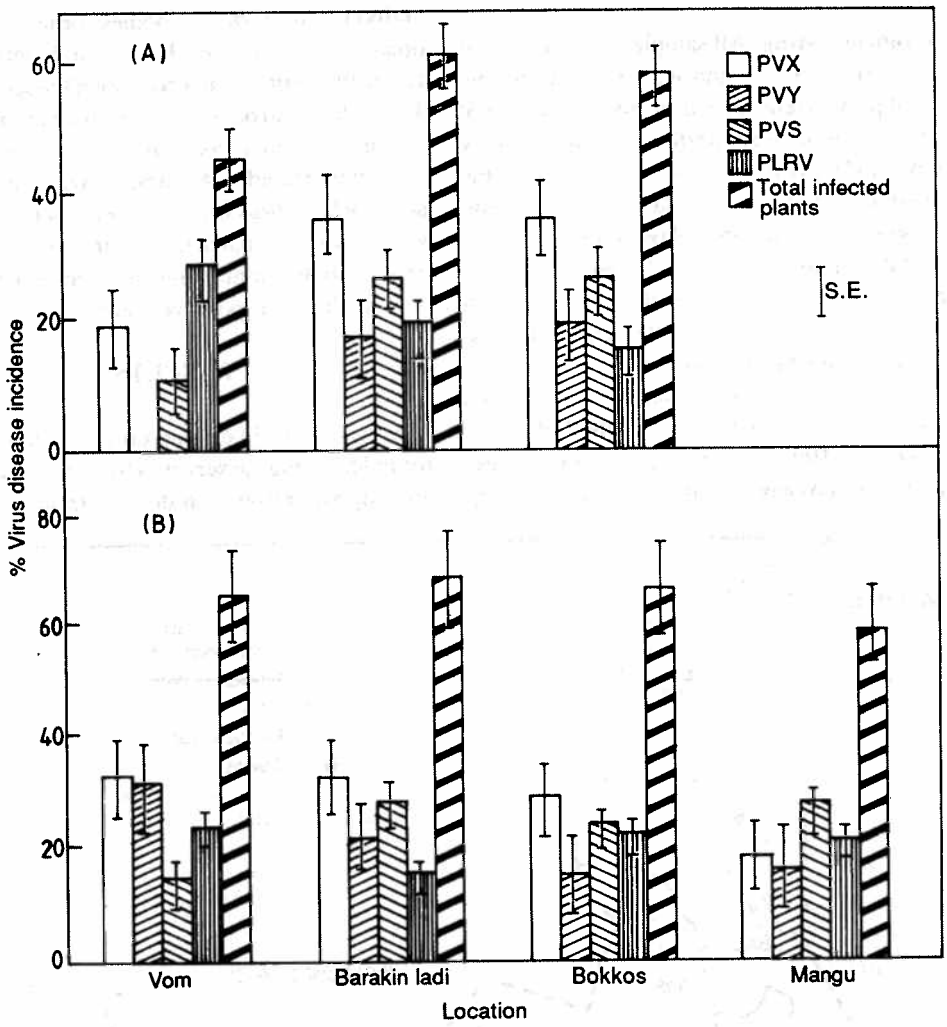

Figure 2. Incidence of infection by four potato viruses in four areas of Jos Plateau, Nigeria, during (A) dry and (B) wet seasons. Individual % virus infections do not sum up to 100% infected plants because of cases of mixed infections

symptoms. In some plants with leaf roll symptoms, entire leaflets were rolled while in others, it was restricted to the leaflet bases. The leaves were also leathery to the feel. Some of the plants showed pallor symptoms in addition to leaf roll, and purple pigmentation was observed at the leaflet bases of some especially the local clone Bakingeneyi and the improved clone Kennebec. Plants with leaf roll symptoms were usually stunted, especially in the local clone Jang Iri.

Four viruses were detected in samples collected during the dry and wet seasons (Fig. 2). In the dry season, the incidence of diseased plants ranged from about 45% in Vom to 62% in Barakin Ladi blocks (Fig. 2A). The incidence of PVX infection was usually the highest except for Vom block where PLRV occurred most, PVY was not detected here during the dry season although it occurred at low levels in both Bokkos and Barakin Ladi blocks. The incidence of PVS infections closely followed that of PVX, while PLRV was mostly detected in less than 20% of the samples in Barakin Ladi and Bokkos blocks.

Diseased samples were more during the wet than the dry seasons. During the wet season, disease incidence was generally above 60%, with

TABLE 1. Incidence of single and mixed infections of potato viruses X, Y, and S and potato leaf roll virus in seed tubers in two localities of the Jos Plateau, Nigeria

Infection type[b]	% Incidence[a]	
	Barakin Ladi	Bokkos
PVX	7.6	10.5
PVY	2.2	1.8
PVS	27.2	21.1
PLRV	1.1	3.3
PVX + PVY	10.9	13.7
PVX + PVS	14.1	13.7
PVX + PLRV	0.0	2.1
PVY + PVS	5.4	3.2
PVY + PLRV	2.3	1.1
PVS + PLRV	3.8	5.4
PVX + PVY + PVS	6.5	4.2
PVX + PVY + PLRV	0.0	2.3
PVY + PVS + PLRV	7.6	6.3
PVX + PVY + PVS + PLRV	1.1	0.0

[a]% Incidence = $\frac{\text{No. of samples positive for each infection type in ELISA x 100}}{\text{No. of samples assayed}}$

[b]PVX, PVY, PVS and PLRV represent potato viruses X, Y, and S and the potato roll leaf virus, respectively. Mixed infections are indicated by the + sign.

Barakin Ladi block having the highest (Fig. 2B). However, in the various localities within the blocks, disease incidence in samples ranged from 46.7% in Pankishin (Mangu block) to 90.9% at Chisu in Bokkos block. Infections by PVX occurred most frequently except for Mangu block where PVS was the most frequent. The incidence of PVS infections was relatively high in most of the areas surveyed except at Vom where it was found usually in less than 20% of the samples. The

TABLE 2. Incidence of mixed infection of viruses in some localities of the Jos plateau, Nigeria during the dry and wet seasons[a].

Locality	% incidence of each mixed infection type[b]			
	PVX + PVY	PVX + PVS	PVX + PLRV	PVS + PLRV[c]
Dry season				
VOM BLOCK	0.0 ± 0.0	11.1 ± 2.15	6.4 ± 0.95	15.6 ± 2.15
BARAKIN LADI BLOCK	18.3 ± 3.05	8.1 ± 1.70	6.5 ± 1.60	18.5 ± 3.00
BOKKOB BLOCK	15.4 ± 4.89	7.1 ± 1.13	8.0 ± 1.02	7.6 ± 1.06
Wet season				
VOM BLOCK	20.8 ± 9.32	4.4 ± 2.31	4.4 ± 1.13	7.2 ± 4.73
BARAKIN LADI BLOCK	17.4 ± 5.03	3.8 ± 2.43	6.7 ± 1.33	6.4 ± 2.11
BOKKOB BLOCK	11.3 ± 3.48	5.6 ± 1.42	3.1 ± 1.25	6.8 ± 2.42
MANGU BLOCK	4.4 ± 2.05	6.7 ± 1.32	0.0 ± 0.0	5.8 ± 3.92

[a]Leaf samples were collected from farmers' fields between June and August 1991 (wet season) and between December 1991 and January 1992 (dry season).

[b]% incidence for each mixed infection type = $\frac{\text{No. of samples positive for that mixed infection type in ELISA x 100}}{\text{No. of samples assayed}}$

[c]PVX, PVY, PVS, and PLRV are potato viruses X, Y, and S, and the potato roll leaf virus, respectively; mixed infections are indicated by + sign, values are means ± SE.

incidence of PVY ranged from 15.1% in Bokkos to 31.3% in Vom blocks while that of PLRV ranged from 15.1% in Barakin Ladi to 23.3% in Vom blocks.

The incidence of viruses in plants from seed tubers was about the same in Barakin Ladi and Bokkos (Table 1). PVS had the highest incidence followed by PVX, PVY and PLRV in that order for both locations. Some plants had various combinations of mixed infections whose incidence was frequently higher than singly infected plants.

Mixed infections were also recorded in the field samples. In the rain fed crop, the incidence ranged from 0.20.8% in various combinations (Table 2). The most common combination was between PVX and PVY while those between PVY and PLRV were the least prevalent, being found in only one sample from Bokkos. Mixed infections involving three viruses were the least frequent. Only one sample infected with PVX, PVS and PLRV was identified at Barakin Ladi and non elsewhere, while two samples from Kirang in Mangu block tested positive for PVX, PVY and PVS. No field sample tested positive for all four viruses although one of such was found in plants from seed tubers (Table 1). The incidence of mixed infections in the dry season irrigated crop essentially followed a similar trend as in the wet season, although incidence values were much lower (Table 2).

Some of the samples which did not manifest any symptoms tested positive for PVS or PVX. This was more common with plants from sprouted seed tubers. In contrast, some field samples showing leaf roll symptoms, especially those with purple pigmentation, did not test positive for any of the viruses.

DISCUSSION

The survey has shown that all viruses assayed for were present in the study area. This should be a cause for concern since these viruses are known to be economically important in other developing countries (Sakizar and Accatino, 1990). The incidence of PVX and other viruses was lower than that reported from other developing countries (Lyon and Peregrine 1974, Ngugi, 1983). Although PVX causes mild infections, this could translate to yield losses of up to 20% (Beuckma and Varder Zaag, 1979; Munro, 1981) especially when present in mixed infections with other viruses as has been observed in this study. Potato viruses X and S are mainly transmitted by mechanical contamination (Becks, 1979; Nayar, 1983). Consequently, these viruses easily spread during farming operations, and this may have accounted for their relatively higher incidence than either PVY or PLRV. PVY and PLRV depend mainly on vectors and propagating material for their spread.

The incidence of potato virus Y was low especially at Vom and Mangu blocks. In Vom, where sampling was done mainly on seed multiplication fields, plants showing any form of virus-like symptoms are usually rouged during the early growth stages, thus reducing the occurrence of the virus. Potato production in Mangu block is low, thus limiting the host population and sample size. Also, the prevalence of late blight (caused by *Phytophthora infestans*) in this area, which can mask virus symptoms (Mkchopadhyay and Sen Gupta, 1967), limited sampling to non-blighted plants to avert the easy deterioration of samples in storage.

The incident of viruses in seed tubers was higher than that observed in the field, although the difference was within field variation. The predominately small size of the seed tubers could represent an unconscious bias selection for infected tubers. For instance, Killick (1979) found that infection with PLRV led to 30% increased in chats per plant.

Mixed infections were very common in both field and seed samples in this survey. Similar observations have been reported elsewhere (Hooker, 1982; Horvath, 1988). The most frequent combination was between PVX and PVY as was also observed in pepper and potato (Makkok and Gumpf, 1974; Jayasinghe *et al.*, 1989). The occurrence of PVX and PVY in mixed infections has since been noted. For example, the two viruses were first isolated from a doubly infected plant in 1931 (Smith, 1931). Also, pre-infection of potato with both or either of PVX and PVY has been shown to reduce the resistance of some clones to PLRV (Jayasinghe *et. al.*, 1989).

Increased host abundance, farm activity and aphid vector activity during the wet season may lead to greater spread of the viruses, thus accounting for their higher incidence in the wet than the dry season.

The lower incidence of viruses in Nigeria relative to other countries with regular seed renewal (Moreira *et al.*, 1980; Heath *et al.*, 1987; Petrunak *et al.*, 1988) indicates a low seed stock degeneration rate and a possible presence of field resistance in some of the local clones. Similar observations have been made in preliminary studies in Cameroon (T. Gass, CIP, Cameroon, 1991, personal communication). This still has to be confirmed in subsequent epidemiological work.

Some of the plants with leaf curl, pallor and purple pigmentation symptoms did not test positive for PLRV. The symptoms resembled those described by Hooker *et al.* (1983) for Solanum apical leaf curl virus (SALCV) but the involvement of the virus could not be confirmed serologically or by infectivity test. This work represents the first report of the occurrence of viruses in potato in Nigeria.

ACKNOWLEDGEMENTS

We thank the following for the provision of antibodies for use in the survey : Dr.S. H. Barker (Scotland), A.F.L.M. Darbs (The Netherlands) and L.F. Salazar (Peru). Third author was supported by a grant from the International Foundation for Science, Sweden.

REFERENCES

Berks, R. 1970. Potato virus X. No. 4. In: *Description of Plant Viruses*. CMI/AAB Kew, Surrey, England.

Beukema, H.P. and Vander Zaag, P. 1979. *Potato Improvement*. International Agriculture Centre, Wageningen, The Netherlands. 224pp.

Clarke, M.F. and Adams, A.N. 1977. Characteristics of the microplate methods of enzyme-linked immusorbent assay for the detection of plant viruses. *Journal of General Virology* 34 : 475–483.

De Bokx, J.A. and Huttinga, H. 1981. Potato virus Y. No. 242 (No. 37 revised) In : *Description of Plant Viruses*. CMI/AAB Kew, Surrey, Britain. 6pp.

FAO. 1990. *Roots, Tubers, Plantains and Bananas in Human Nutrition*. FAO Food and Nutrition series No. 24. Food and Agricultural Organisation of the United Nations, Rome. 182pp.

Harrison, B.D. 1984. Potato leafroll virus. No. 291 (No. 36 revised). *Description of Plant Viruses*. CMI/AAB, Kew, Surrey, England. 6pp.

Heath, R.J., Sward, R.J., Moran, J.R., Mason, A.J. and Hallam, N.D. 1987. Biological characterization of six Australian isolates of potato virus Y and their serological detection by ELISA. *Australian Journal of Agricultural Research* 38 :395–402.

Hooker, W.J. 1982. *Virus Diseases of Potato*. Technical Information Bulletin No. 19. International Potato Center (CIP), Lima-Peru. 17pp.

Hooker, W.J., Salazar, L.F. and Brown, C.R. 1983. A virus associated with symptoms resembling purple top wilt in potato. In: *Research for the Potato in the Year 2000*. Hooker, W.J. (Ed.), pp 95–96. International Potato Center (CIP), Lima, Peru.

Horvath, J. 1988. Potato gene centres, wild solanum species, viruses and aphid vectors. *Acta Phytopathologia Academiae Scienthiarum Hungaricae* 23 : 423–488.

Ifenkwe, O.P. and Suchomel, D.R. 1983. Prospects of large scale production of potato in Nigeria. In: *Research for Potato in the Year 2000*. Hooker, W.J. (Ed.), pp. 100–101. CIP, Lima, Peru.

Jayasinghe, U., Chuquillanqui, C. and Salazar, L.F. 1989. Modified expression of virus resistance in potato in mixed virus infections. *American Potato Journal* 66:137–144.

Jones, R.A.C. and Fuller, N.J. 1984. Incidence of potato virus in potato stocks in England and Wales. *Plant Pathology* 33: 595–597.

Killick, R.J. 1979. The effect of infection with potato leaf roll virus on yield and some of its components in a variety of potato (*Solanum tuberosum* L). *Annals of Applied Biology* 91(1) : 67–74.

Lockhart, B.E.L. and Fischer, H.U. 1974. Serious losses caused by potato virus Y infection in peppers in Morocco. *Plant Disease Reporter* 58: 141–143.

Lockhart, B.E.L. and Fischer, H.U. 1976a. A strain of potato virus Y causing calico disease of tobacco in Morocco. *Plant Disease Reporter* 60: 110–113.

Lockhart, B.E.L. and Fischer, H.U. 1976b. A disease of tobacco in Morocco caused by

veinal necrosis strain of potato virus Y. *Plant Disease Reporter* 60: 114–116.

Lyon, N.C. and Peregrine, W.T.H. 1974. Prevalence of potato viruses, X, S and M in Malawi. *Tropical Agriculture (Trinidad)* 51(4):543–547.

Makkouk, K.M. and Gumpf, D.J. 1974. Further identification of naturally occurring viruses on pepper in California. *Plant Disease Reporter* 58: 1002–1006.

Moreira, A., Jones, R.A.C. and Fribourg, C.E. 1980. Properties of resistance - breaking strain of potato virus X. *Annals of Applied Biology* 95: 93–103.

Mukhopadhyay, S. and Sen Gupta, P.C. 1967. Susceptibility of some potato varieties to the natural infection of late blight disease and the influence of mild mosaic infection on its expression in the field. *Indian Agriculturist* 2: 139.

Munro, J. 1981. Potato Virus X. In: *Compendium of Potato Diseases*. Hooker, W.F. (Ed.), pp. 77–72. American Phytopathological Society, St. Paul, Minnesota, USA.

Nayar, N.M. 1989. Importance and problems in breeding virus resistant potato varieties. In : *National Symposium on Epidemiology of Viral Diseases*, Hilma, Oct. 17–19, 1989 India. (Abst).

Ngugi, D.N. 1983. Potato production in Kenya: potentials and limitations. In: *Research for Potato by the year 2000*. CIP, Lima, Peru. pp 140–142.

Obigbesan, C.O. 1976. Report on Potato production in Nigeria. In : *Report of Participants of International Course on Potato Production*. Wageningen, The Netherlands. pp 64–71.

Petrunak, D.M., Gildow, F.E. and Christ, B.J. 1988. Survey of potato viruses in Pennyslania. *Phytopathology* 78:863 (Abst.)

Salazar, L.F. 1990. Main virus diseases of potato. In: CIP. *Control of virus and virus-like diseases of potato and sweet potato*, pp. 9–12. Report of 3rd Planning Conference, Lima, Peru, 20–22 Nov. 1989.

Salazar, L.F. and Accatino, P. 1990. The importance of potato virus diseases in developing countries. In: CIP. *Control of virus and virus-like virus-like diseases of potato and sweet potato*, pp 21–28. Report of 3rd Planning Conference Lima, Peru, 20-22 Nov, 1989.

Singh, S. and Barker, H. 1991. Comparison of penicillinase - based and alkaline phosphatase - based enzyme - Linked immunosorbent assay for the detection of six potato viruses. *Short Communication for Potato Research*. Scottish Crop Research Institute, Invergowrie, Dundee. 14pp.

Smith, K.M. 1931. Composite nature of certain potato viruses of the mosaic group. *Nature* 127 : 852–853.

Wetter, C. 1971. Potato virus S. No. 60. In: *Description of Plant viruses*. CMI/AAB Kew, Surrey, England. 3pp.

Wilson, C.R. and Jones, R.A.C. 1990. Virus content of seed potato stocks produced in a unique seed potato scheme. *Annals of Applied Biology* 116: 103–109.

Yusuf, A. 1988. Survey on potato and tomato viruses diseases in major growing areas (Ambo, Bako and Guder). In : S.P.L. Progress Report 1987/88. Ethiopia, pp. 322–323.