



Mini Review

Viral Diseases of Crops in Nepal

Nabin Sharma Poudel^{1*}, Kapil Khanal²

¹Department of Plant Pathology, AFU, Rampur, Nepal

²Department of Agricultural Economics and Agribusiness Management, AFU, Rampur, Nepal

Abstract

Viral diseases are the important diseases next to the fungal and bacterial in Nepal. The increase in incidence and severity of viral diseases and emergence of new viral diseases causes the significant yield losses of different crops in Nepal. But the research and studies on plant viral diseases are limited. Most of the studies were focused in viral diseases of rice (*Rice tungro virus* and *Rice dwarf virus*), tomato (*Yellow leaf curl virus*) and potato (PVX and PVY). *Maize leaf fleck virus* and mosaic caused by *Maize mosaic virus* were recorded as minor disease of maize. Citrus Tristeza Virus is an important virus of citrus fruit in Nepal while *Papaya ringspot potyvirus*, *Ageratum yellow vein virus* (AYVV), *Tomato leaf curl Java betasatellite* and *Sida yellow vein Chinaalphasatellite* were recorded from the papaya fruit. The *Cucumber mosaic virus* (CMV) and *Zucchini yellow mosaic potyvirus* (ZYMV) are the viral diseases of cucurbitaceous crop reported in Nepal. *Mungbean yellow mosaic India virus* (MYMIV) found to infect the many crops Limabean, Kidney bean, blackgram and Mungbean. *Bean common mosaic necrosis virus* in sweet bean, *Pea leaf distortion virus* (PLDV), *Cowpea aphid-borne mosaic potyvirus* (CABMV), *Peanut bud necrosis virus* (PBNV) in groundnut, *Cucumber mosaic virus* (CMV). *Chili veinal mottle potyvirus* (CVMV) and *Tomatoyellow leaf curl gemini virus* (TYLCV) were only reported and no any further works have been carried out. The 3 virus diseases *Soyabean mosaic* (SMV), *Soybean yellow mosaic virus* and *Bud blight tobacco ring spot virus* (TRSV) were found in soybean.

Keywords: Diseases; Losses; Nepal; Viral

Introduction

Nepal is an Agricultural country where about 65% of total people are involved in agriculture. Most of them are dependent in the agriculture for sustaining the life. At present context there are various constraints in Nepalese agriculture. Among them plant diseases one of the major constraints in crop production in Nepal. Plant diseases cause both qualitative as well as quantitative losses in Agriculture with negative impact on the economy of Nepal. Past and the present viral disease scenario indicated that the occurrence of several viruses on cereals, cucurbits, legumes and

Solanaceous vegetables and other crops in epidemic form in the country. The incidence and severity of viral disease is increasing. New viruses like diseases are also emerging. Research and studies on plant viruses are limited in Nepal. In recent years, virus diseases caused significant yield losses. Viral disease has created a threat for production and productivity of important crop plants. Deteriorate both quality and quantity of produce and ultimately reduces market price and affect the national economy of the country.

Cite this article as:

N.S. Poudel and K. Khanal (2018) Int. J. Appl. Sci. Biotechnol. Vol 6(2): 75-80. DOI: [10.3126/ijasbt.v6i2.19702](https://doi.org/10.3126/ijasbt.v6i2.19702)

^{1*}Corresponding author

Nabin Sharma Poudel,
Department of Plant Pathology, AFU, Rampur, Nepal
Email: agrinabin53@gmail.com

Peer reviewed under authority of IJASBT

© 2018 International Journal of Applied Sciences and Biotechnology



This is an open access article & it is licensed under a Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by/4.0/>)

Viral Diseases of Cereals

Viral diseases of Rice

Rice tungro badnavirus/machlovirus

Rice tungro disease had been first reported from Parwanipur research station based on field symptoms and transmission studies (John *et al.*, 1979a). Later from the plant sample collected from Hardinath Agriculture Farm, Janakpur; virus particle of tungro was identified in electron microscope examination (Omura *et al.*, 1981; Dahal *et al.*, 1996a). This disease was also reported in Kathmandu Valley later (Amaty and Manandhar, 1986). Based on particle morphology and serology Omura *et al.* (1981, 1982) identified the presence of rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV) from tungro-like rice plants. Dahal *et al.* (1996a) surveyed from 21 districts of terai region of Nepal and found that rice tungro was primarily restricted to the Hardinath (Janakpur) and Parwanipur (Bara) regions. The tungro incidence in Hardinath ranged from 17% to 51% and in Parwanipur from 6% to 61% causing about 89% grain yield loss in Hardinath. In the same year the rice tungro virus was found in some pockets of Janakpur and Bara districts and of rice dwarf in Kathmandu Valley (Dahal *et al.*, 1996b). On mass inoculation of 15 popular rice cultivars most became more than 50% infected and only cultivar Radha 9 had low (22.2%) infection (Dahal *et al.*, 1996a).

Rice dwarf virus

Rice dwarf virus was reported in cultivars Taichung 176 and KT 32-2 (John *et al.*, 1979b). The finding was later confirmed by Omura *et al.* (1982) by electron microscopic examination of infected material collected in Nepal. Based on SDS-immunodiffusion test, the Nepalese isolate of RDV was shown to be similar to the Japanese RDV isolate. In Nepal the virus is transmitted by both male and female leafhopper *Nephotettix nigropictus* in a persistent manner (John *et al.*, 1979a; Omura *et al.*, 1982). Nymphs are more efficient in transmitting the virus than adult (Pradhan and Khattri, 1980). According to Upadhyay and Lapis (1982) among the 44 screened germplasm 10 are observed to be tolerant while others are moderately to highly susceptible. Out of them, seven were designated as IR20, IR 2071-627-1, IR C3707-117 2, IR2797-125, Tetep, IR 1416-128-5-8 and IR 1905-81-3-1 showed the 0.5% seedling infection. Other three entries named IET2938, IR 1544-340-6-1 and IR 1905P 11-29-4-1 showed 6-25% seedling infection. Remaining showed susceptible reaction to rice dwarf ranging from moderate to high.

Viral Diseases of Maize

Maize disease investigation was initiated in 1964-65 when there was not one improved variety of maize in the country (Manandhar, 1983). According to Manandhar, (1983) the incidences of virus diseases have been reported in maize in

Nepal, but none of the virus diseases have been unquestionably identified. The initial reports of Leaf fleck caused by *Maize leaf fleck virus* and Mosaic caused by *Maize mosaic virus* were recorded both in hill and Terai (Subedi, 2015).

Viral Diseases of Fruits

Citrus

Citrus virus and virus-like diseases were unknown in Nepal prior to the importation of grafted citrus from Saharanpur (Uttar Pradesh) in India in the 1960's (Lama, T. K. 1996). The first record of Citrus tristeza virus (CTV) in Nepal was in 1971 (Knorr and Moin-shah, 1971). According to Regmi *et al.* (2001) among two strains of CTV virus found in Nepal the first strain is endemic and causes stem pitting and vein clearing symptoms only on lime and does not show symptoms in sweet orange and mandarin while the second strain shows symptoms on sweet orange and mandarin. Regmi and Shrestha (1993) introduced the practice of shoot-tip grafting to eliminate viruses from budwood sources. Regmi *et al.* (2001), found the incidence of CTV (non-stem pitting strain on mandarin) was about 7.7 percent with several colonies of aphids – which are vectors of Citrus Tristeza Virus (CTV) in different orchards of Baitadi.

Papaya

Dahal *et al.* (1997) observed the symptoms of papaya ringspot potyvirus- watermelon strain (PRSV-W) on papaya in 18 terai and inner terai districts of Nepal during 1989 and 1992 to 1994. The virus isolated from papaya was confirmed as papaya ringspot potyvirus- watermelon strain (PRSV-W). From leaf samples of *Carica papaya* plants with leaf curling, vein darkening, vein thickening, and a reduction in leaf size collected from Rampur, Nepal in 2010 an isolate of *Ageratum yellow vein virus* (AYVV), Tomato leaf curl Java beta satellite and Sida yellow vein China alpha satellite were isolated (Shahid *et al.*, 2013). This was the first identification in papaya in Nepal.

Viral diseases of Vegetables

Potato

PLRV, PVS, PVX, PVY, PVA and PVM are known to be the major potato viruses of economic importance in Nepal (Akius and Kloos 1990; Ranjit *et al.*, 1994; Sakha *et al.*, 2007). Khatri and Shrestha (2004) tested 21 local cultivars and the tubers of almost all tested stocks were found infected by virus diseases and cultivars Farse White, Rosita, Khumbule and Lumle Red were superior to Kufri Jyoti in tuber yields. Jumli Local, Kathmandu Local, Sarkari Seto, Syang Dorje and Tharu Local were cleaned against six potato viruses (A, X, M, Y, S and leaf roll) at Khumaltar (Khatri and Rai, 2000).

Tomato

Tomato leaf curl virus (TLCV) is becoming a serious problem in the tomato crop of terai and foothills (Shrestha, *et al.*, 1997). Ghimire, *et al.* (2001) reported incidence of the disease in most tomato growing pockets and yield losses of 40% or even higher in some areas like Risingpatan, Tanahun and Kudule, of western hills of Nepal. Plant disease monitoring by Lumle Agricultural Research Centre (LARC) through its network of off-station research sites (OSR), outreach research sites (OR) found severe infestation of the Tomato Yellow Leaf Curl Virus (TYLCV virus) disease occurred in tomato growing areas of Dhanubase, Yampaphant and Rishing Patan in fiscal year 1994/95 (Sharma *et al.*, 1996). The causal agent of leaf curl disease is known as geminivirus that is transmitted by white fly (*Bemisia tabaci* Gen.) in a semi-persistent manner (Shrestha, *et al.* 1997). All exotic tomato cultivars are susceptible to leaf curl virus however, some local indeterminate cultivars have been observed as tolerant to Tomato Leaf Curl Virus. Malla *et al.* (2000;2002) reported varieties ATY 3, ATY 5, and ATY 6 were resistant to TYLCV whereas NCL1, BL410 and Pusa ruby showed moderate level of TYLCV incidence. The seedling raised under mulching cloth+without mulching showed the highest fruit yield and lowest Tomato Yellow Leaf Curl Virus (TYLCV) incidence and the use of straw mulching on tomato field had significant effect on reducing disease (Malla *et al.*, 2000, 2001).

Cucurbitaceous crops

The virus isolated from zucchini, ash-gourd, bitter-gourd, snake gourd, spongegourd, watermelon, bottlegourd and cucumber virus like symptoms and mosaic or yellow mosaic, blisters, and leaf distortion was confirmed as papaya ring spot potyvirus watermelon strain and Leaf extract of ash gourd cucumber and pumpkin reacted to antibody against cucurbit aphid borne yellow luteovirus (CABW) also From leaf samples of Cucumber, chayote, pumpkin, zucchini and snakegourd isolated cucumber mosaic virus (CMV) and zucchini yellow mosaic potyvirus (ZYMV) (Dahal *et al.*, 1997). ZYMV and CABW was first report in Nepal. The zucchini yellow mosaic virus was epidemic in most of farmers' fields at low elevations (about 250 m) and much less at higher altitudes (>1500 m) and the spread of disease was more than 8.5% per day during both pre- and post-monsoon seasons (Dahal, 1992). A research on management of viral diseases of cucurbits crops conducted by (Joshi *et al.*, 2012) concluded that there is no chemical which control virus but fresh cow milk, Anti-VS, Liposome and Victovirus helped to lower the virus severity.

Limabean and Kidney bean

Shahid *et al.* (2012) first reported MYMIV (Mungbean yellow mosaic India virus) from *Phaseolus vulgaris* (Kidney bean) and lima bean (*Phaseolus lunatus*) plants showing severe mosaic, yellowing and leaf curling

symptoms from vicinity of Chitwan, Nepal and the incidence of disease was 70-80%.

Sweet Bean

The first report of Bean common mosaic necrosis virus (BCMNV) was from sweet bean with mottle and leaf deformation, severe mosaic, necrosis, malformation of leaves in Nepal in December 2010 (Pudashini *et al.*, 2013).

Pea

Electron microscopic examination of leaf extracts from leaves showing symptoms narrow and/or curled, and stunting of pea plants at Rampur revealed pea seed-borne mosaic potyvirus (PSBMV) (Dahal and Albrechtsen, 1996). *Pea leaf distortion virus* (PLDV) was also reported from Rampur, Nepal (Shahid *et al.*, 2017).

Cowpea

Dahal and Albrechtsen, (1996) recorded symptoms of cowpea aphid-borne mosaic potyvirus (CABMV) during 1989–1990 at Rampur which was transmitted by both aphids and sap inoculations. The incidence was higher in the late planted pea crop (January) than those planted in November and December. Different virus-like symptoms have been reported from the experimental plots of IAAS farm (Timilsina, 1988; Neupane and Pant, 1988) and farmer's field of Chitwan district.

Okra

(Dahal, 1990) reported the virus like symptoms on cultivar Pusa sawani with reduced leaf lamina and a typical interwoven network of yellow veins and complete chlorosis of younger leaves at the advance stage.

Chili

The viral disease problem of pepper in Nepal is complex more than one viruses attack simultaneously (Joshi and Shrestha, 1999). Cucumber mosaic virus (CMV), Chili veinal mottle potyvirus (CVMV) and Tomato yellow leaf curl gemini virus (TYLCV) were the most common viruses identified in Nepal (Joshi and Shrestha, 2001). During March and September 1989, few dwarf plants of chilies, both sweet pepper and hot chilies (cv. Pusa jwala) were observed with Initial symptoms of dwarf, light green foliage, leaf curl, cupping upward/downward, and leaf distortion (Dahal, 1990). Timila *et al.* (1994) also reported the occurrence and distribution of TYLCV in tomato and chilli.

Brinjal

Brinjal plants with symptoms like mosaic, reduced and distorted leaves, and short internodes exhibiting a bushy appearance were observed during first week of September, 1989 (Dahal, 1990).

Broad leaf mustard

The occurrence of the mosaic disease of broad leaf mustard was reported, diagnose & identified (Shrestha 1983

&1984). The possible occurrence of mosaic virus on radish and turnip has also been suspected (Shrestha, 1984).

Viral Diseases of Oilseed crops (Soyabean and Groundnut)

The most common virus is soyabean yellow mosaic virus among the 3 virus diseases of soyabean that were found in Nepal (Manandhar and Sinclair, 1982). Soyabean mosaic (SMV) and bud blight (tobacco ring spot virus, TRSV) in soyabean in Kathmandu valley and terai region was reported by (Manandhar, 1979). Gharti *et al.*, (2010) reported 6 genotypes PI 94159,G-8754, Dashratpur, SB 0095, CM 9125 and TAMPOMAS were found highly resistance to Mungbean yellow mosaic virus(Gharti *et al.* 2010; Shrestha *et al.*, 2011). Sharma (1996) conducted yield loss assessment study between 1992 and 1995 at Nawalpur, revealed that cumulative disease incidence of Peanut bud necrosis virus (PBNV) was 20%; pod yield loss reached 27.7% and infects during the early stage of crop growth.

Viral diseases of Legumes (Mungbean and Blackgram)

Mungbean yellow mosaic virus is the most important disease of summer legumes in warm humid subtropical regions of Nepal. Srivastava (2010) reported Pratikshya and kalyan have been recently released by National Seed Board were resistance to mungbean yellow mosaic virus. In screening nursery of Mungbean Yellow Mosaic Virus of mungbean and blackgram, IPM-16 genotype of mungbean were found highly resistant whereas Bari Mash-1, Bari Mash-2, Bari Mash-3 of blackgram and Bari Mung-2, Pratikshya, Hum 12genotypes of mungbean were resistant and BLG 0003-2-1 genotype of blackgram were found moderately tolerant (Gharti, 2013). According to Gharti (2013) spray of Cow's milk and leaf extract of mixture of botanicals were effective to reduced severity, increased hundred seed weight and improved grain yield.

Spices crop (Cardamom)

The 'Foorkey' (dwarf) and 'Chhirke' (mosaic or streak) disease of large cardamom have been reported as serious problem in cardamom cultivation (Dahal *et al.*, 1988). The author has indicated that the dwarf disease of cardamom was more serious than the mosaic or streak diseases. The experiments carried by Subedi and Paudyal (2008) found that invitro plant regeneration by multiple shoot formation from meristemic tissue of large cardamom helps for the rapid multiplication of disease free planting materials.

Conclusion

The viral diseases are as important as the fungal and bacterial diseases in Nepal causing subsequent losses in yield of different crops but the studies and research works are limited in Nepal. The works should now be focused on the molecular level as well as the best management practices of the various diseases as the farmers want the best

results and the high output. Only the researches are being focused in some of the major crops like rice, potato and tomato but not in the minor and indigenous crops which are the main crop for the farmers of rural Nepal. Therefore, the Agriculture research body of Nepal (NARC) should focus in the viral disease of crops also should coordinate with NAST, Department of Agriculture, AFU and IAAS.

Acknowledgement

The author acknowledges Hira Kaji Manandhar, PhD, Ex-Senior Scientist, Nepal Agricultural Research Council who guided for the manuscript and providing suggestions.. Sincere thanks to all the members of Department of Plant Pathology, AFU Rampur, Chitwan.

References

- Akius M and Kloos JP (1990) Viral diseases spread and detection in Nepal. *In: Proceeding of 11th European Association for potato Research (EAPR)*, Edinburgh, UK. 66-67.
- Dahal G (1990) Occurrence of virus and virus-like Diseases of crop plants in Nepal. *Journal of Institute of Agriculture and Animal Sciences* **11**: 47-75.
- Dahal G (1992) Occurrence and epidemiology of a potyvirus-like disease of zucchini squash in Nepal. *International Journal of Pest Management* **38**(2): 144-151. DOI: [10.1080/09670879209371672](https://doi.org/10.1080/09670879209371672)
- Dahal G and Albrechtsen SE (1996) Some studies on cowpea aphid-borne mosaic and pea seed-borne mosaic potyviruses in Nepal. *International journal of pest management* **42**(4): 337-344. DOI: [10.1080/09670879609372018](https://doi.org/10.1080/09670879609372018)
- Dahal G, Amatya P and Manandhar HK (1992) Plant diseases in Nepal. *Review of Plant Pathology* **71**(11): 797-807.
- Dahal G, Amatya P and Regmi C (1988) Plant viruses in Nepal: Status and Prospects. *Journal of Institute of Agriculture and Animal Sciences*, **9**: 119-126.
- Dahal G, Druka, A, Burns, TM, Villegas LC, Fan Z, Shrestha RA, and Hull R (1996a). Some biological and genomic properties of rice tungro bacilliform badnavirus and rice tungro spherical waikavirus from Nepal. *Annals of applied biology* **129**(2): 267-287. DOI: [10.1111/j.1744-7348.1996.tb05751.x](https://doi.org/10.1111/j.1744-7348.1996.tb05751.x)
- Dahal G, Hull R, Druka A, Murao K, and Uyeda I (1996b) Biological and molecular characteristics of rice dwarf and tungro viruses in Nepal. In *Rice Genetics III* **2**: 929-933.
- Dahal G, Lecoq H and Albrechtsen SE (1997) Occurrence of Papaya ringspot potyvirus and Cucurbit viruses in Nepal. *Annals of applied biology*, **130**(3): 491-502. DOI: [10.1111/j.1744-7348.1997.tb07677.x](https://doi.org/10.1111/j.1744-7348.1997.tb07677.x)
- Dahal G, Neupane FP and Baral (1990) Effect of insecticidal application and the time of planting on the incidence and spread of the yellow vein mosaic disease of okra in Chitwan, Nepal. In. *J. Trop. Plant Dis.*
- Gharti DB, (2013) An Overview of Summer Legumes Research and Development in Nepal. In *Proceedings of the 27th National Summer Crops* **2**:409-416.

- Gharti DB, Daral R and Banstola BS (2010) Identification of level of field resistance to major diseases in available genotypes of soyabean at Nglrp, Rampur during 2005-2007. In *Proceeding of the 25th Summer Crops Workshop*. 402-409
- Gharti DB, Subedi S and Ghimire TN (2013) Validation of farmer's Indigenous Knowledge to Manage Mungbean Yellow Mosaic Virus in Blackgram. In *Proceedings of the 27th National Summer Crops Workshop*, 1:1319-322
- Ghimire SR, Subedi PP, and Green SK (2001) Status of tomato yellow leaf curl virus in tomato in the western hills of Nepal. *Nepal Agriculture Research Journal*, 4:1-4.
- John VT, Freeman WH, and Shahi BB (1979a) Occurrence of tungro disease in Nepal. *International Rice Research Newsletter*, 4(5).
- John VT, Heu MH, Freeman WH, and Manandhar DN (1979b) A note on dwarf disease of rice in Nepal. *Plant Disease Reporter*, 63(9): 784-785.
- Joshi S and Shresiha SK (1999) Incidence and distribution of Tomato yellow leaf curl virus and cucumber mosaic virus in tomato and chili. Proceedings Third National Conference on Science and Technology March 8-II, 1999. Royal Nepal Academy of Science and Technology. 1082-1086.
- Joshi S and Shrestha SK (2001) Integrated disease and pest management leaf curl and other viruses of tomato and pepper. Proceedings of the South Asia Vegetable Research Network (SAVERNET II) Final Workshop. 3-8 June 2001. Bangkok. Thailand. Asian Vegetable Research and Development Center, Shanhua, Tainan, Taiwan
- Khadka BB and Shah SM (1967) Preliminary list of plant diseases recorded in Nepal. *Nepalese Journal of Agriculture*. 2: 47-76.
- Khatri BB and GP Rai (2000) Potato Production in Nepal. In: *Proc. of Improving the Efficiency of Potato Production and Marketing in Indonesia, the Philippines, Vietnam and Nepal, August 3-4, 2000* (PJ Batt, R Lawrence and C Piggan, eds). Adelaide, South Australia. 59-70.
- Khatri BB and Shrestha SL (2004) Some Local Potato Cultivars and their Reaction to Viruses. In *Nepal Agriculture Research Journal* 5: 19-21.
- Knorr LC and Moin-Shah S (1971) World citrus problems. *FAO Plant Prot Bull*.
- Lama TK (1996, January) Present status of virus and virus-like diseases of citrus in Nepal. In *International Organization of Citrus Virologists Conference Proceedings (1957-2010)*. 13(13).
- Malla S, Dahal SP, Manandhar R and Devkota SR (2000) Cultural management of tomato yellow leaf curl virus disease of tomato and varietal screening for resistance. In *Lumle Seminar Paper (Nepal)*. Agriculture Research Station.
- Malla S, Dahal SP, Manandhar R and Devkota SR (2001) Management of tomato yellow leaf curl virus (TYLCV) disease in tomato through cultural method. *Lumle Working Paper (Nepal)*.
- Malla S, Dahal SP, Manandhar R, and Devkota SR (2002) Tomato varietal screening against tomato yellow leaf curl virus (TYLCV) in 2000. *Lumle Working Paper (Nepal)*.
- Manandhar JB and Sinclair JB (1982) Occurrence of soybean diseases and their importance in Nepal. *FAO plant protection Bulletin*, 30(1):13-16.
- Manandhar KL (1979) Report on soyabean diaseses. *Summer crops seminar*, parwanipur, Feb 25, 1980.
- Manandhar KL (1983) Investigation of maize diseases in Nepal - I: Identification and prevalence. *Journal of Institute of Agriculture and Animal Science* 4: 45-56.
- Neupane KR and Pant J (1988) Performance of vegetable type cowpea in Rampur, Chitwan. *Journal of Institute of Agriculture and Animal Sciences* 9:127-128.
- Omura T, Inoue H, Pradhan RB, Thapa BJ and Saito Y (1982) Identification of ricedwarf virus in Nepal. *Tropical Agri. Res. Quart*, 15 (3) :218-220.
- Omura T, Inoue H, Thapa UB, and Saito Y (1981) Association of rice tungro spherical and rice tungro bacilliform viruses with the rice diseases from Janakpur, Nepal. *International Rice Research Newsletter* 6(6): 14.
- Pradhan RB and Khatri NK (1980) Report of occurrence of rice dwarf virus in Kathmandu in Kathmandu vally. Paper presented at the 8th summer crop seminar, 1977-78. Department of agriculture, Harihar Bhawan, Lalitpur.
- Pudashini BJ, Shahid MS, and Natsuaki KT (2013) First report of bean common mosaic necrosis virus (BCMNV) infecting sweet bean in Nepal. *Plant Disease* 97(2): 290-290. DOI: [10.1094/PDIS-08-12-0741-PDN](https://doi.org/10.1094/PDIS-08-12-0741-PDN)
- Ranjit M, Rai GP, Manandhar A and Pandey V (1994) Virus testing and elimination of viruses from some local cultivars of potato (*Solanum tuberosum*) in Nepal. In: *Proceedings of 4th Asian Potato Association (APA) Triennial Conference*, 5-7 Jul. 1994 (ET Rasco, FB Aromin and CH Balaltro, eds). Daekwonryeong, Korea. 95-99.
- Regmi C and Shrestha S (1993) Modification of Shoot Tip Grafting technique for increasing efficiency of successful grafts. In *International Organization of Citrus Virologists Conference Proceedings (1957-2010)*. 12 (12).
- Sakha M, Rai GP, Dhital SP and Nepal RB (2007) Disease-free Pre-Basic Seed Potato Production through Tissue Culture in Nepal. In *Nepal Agriculture Research Journal* 8: 7- 13.
- Shahid M.S, Yoshida S, Khatri-Chhetri GB, Briddon RW, and Natsuaki KT (2013) Complete nucleotide sequence of a monopartite Begomovirus and associated satellites infecting *Carica papaya* in Nepal. *Virus genes* 46(3): 581-584. DOI: [10.1007/s11262-013-0888-0](https://doi.org/10.1007/s11262-013-0888-0)
- Shahid MS, Ikegami M, and Natsuaki KT (2012) First report of Mungbean yellow mosaic India virus on Lima bean affected by yellow mosaic disease in Nepal. *Australasian Plant Disease Notes*, 7(1): 85-89. DOI: [10.1007/s13314-012-0055-9](https://doi.org/10.1007/s13314-012-0055-9)

- Shahid MS, Pudashini BJ, Khatri-Chhetri GB, Briddon RW, Natsuaki KT (2017) Molecular characterization of a distinct monopartite begomovirus associated with betasatellites and alphasatellites infecting *Pisum sativum* in Nepal. *Virus genes* **53**(2): 300-306. DOI: [10.1007/s11262-016-1424-9](https://doi.org/10.1007/s11262-016-1424-9)
- Shahid MS, Pudashini BJ, Khatri-Chhetri GB, Ikegami M, and Natsuaki KT (2012) First report of Mungbean yellow mosaic India virus on kidney bean in Nepal. *New Disease Reports* **25**: 30-30. DOI: [10.5197/j.2044-0588.2012.025.030](https://doi.org/10.5197/j.2044-0588.2012.025.030)
- Sharma BP (1996) Current status of research on legume viruses with special reference to groundnut viruses in Nepal. In *4. Meeting of the International Working Group on Groundnut Virus Diseases in the Asia-Pacific Region. KhonKaen (Thailand). 12-14 Mar 1995.*
- Sharma S and Ghimire SR (1996) Plant disease monitoring and disease diagnosis, 1994/95. *LARC Working Paper (Nepal).*
- Shrestha K (1983) Major diseases and control of vegetable crops. Proceedings of Second Workshop Seminar on Vegetable Seed Production, Jan 31 to Feb 4, 1983, Kathmandu; Vegetable Dev. Division, HMG, Nepal.
- Shrestha K, Shrestha SK, Timila RD and Joshi S (1997) Tomato leaf curl disease: a white fly transmitted gemini virus of tomato in Nepal. *Nepalese Journal of Agriculture (Nepal).*
- Shrestha R, Neupane RK and Adhikari NP (2011) Status and future prospects of pulses in Nepal. In *Regional Workshop on Pulse Production held at Nepal Agricultural Research Council (NARC), Kathmandu, Nepal*: 24-25.
- Shrestha SK (1984) Study on mosaic disease of broad leaf Mustard and other cruciferous vegetables in Nepal. *Nep J Agri* **15**: 155-164.
- Srivastava SP (2010) Highlights of grain legumes research in Nepal, 2004- 2005. In *Proceeding of the 25th Summer Crops Workshop*.292-297.
- Subedi GD and Paudyal KP (2008) *In Vitro* Plant Regeneration of Large Cardamom (*Amomum subulatum* Roxb.) for Virus Elimination.5th National seminar on horticulture June 9-10.
- Subedi S (2015) A review on important maize diseases and their management in Nepal. *Journal of Maize Research and Development*, **1**(1):28-52. DOI: [10.3126/jmrd.v1i1.14242](https://doi.org/10.3126/jmrd.v1i1.14242)
- Timila RD, Joshi S and Shrestha K (1994) Report on leaf curl virus in tomato and chili crop in Nepal. Paper presented at SAVERNET midterm workshop held at Nangalore. India. September 12- 15, 1994.
- TimilsinaJ (1988) Performance of ITA's grain and vegetable type cowpea in Chitwan,Nepal. *Journal of Institute of Agriculture and Animal Sciences* **9**:21-27.
- Upadhyay BP and Lapis DB (1982) Tetep: a potential source of resistance to rice dwarf virus in Nepal.*International Rice Research Newsletter* **7**(5): 7-9.