Research Article

IDENTIFICATION OF MAJOR DISEASES OF TOMATO FROM DIFFERENT LOCATIONS OF NEPAL

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ABSTRACT

Tomato is the important vegetable crop grown throughout the year in Nepal with the introduction of plastic house for off season production. Diseases are one of the major constraints on cultivation of crops and reduce production and productivity. Accurate disease diagnosis and proper identification of their causal agents is the primary stages of disease management strategy. With the objective of finding out the diseases infecting tomato crop and their distribution in the country, the study was carried out. During fiscal year 2074/75 (2017/18 AD) and 2075/76 (2018/19 AD), 143 different tomato disease samples were received/collected from various locations of the country. Of the samples 90% were from plastic tunnels and rest was from open fields. The samples were processed and diagnosed using standard laboratory techniques at laboratory of Plant Pathology Division (PPD), Khumaltar, Lalitpur. Examination of those samples showed 53 samples were infected with fungal pathogens, 28 with bacterial, 54 with viral and 8 were infected with nematode. In terms of percentage, 37% of the samples infected by fungus 20% by bacteria, 37% by virus and 6% were infected by nematodes. It shows that virus diseases infecting tomato are in increasing trend approaching to be equal to fungal diseases. The activities of carrying out disease diagnosis help to know the distribution of the diseases in the country, help to explore new disease outbreak and its epidemiology, and provide information for disease management. It also helps to prioritize disease for research area. However disease samples from more area should be there to represent the disease situation in the country

Key words: *Bacteria, disease diagnosis, fungus, nematode, virus*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the major commercial vegetable crops in Nepal (*Ghimire et al*., 2001). Though tomato is best suited to the terai, in low and mid hills, it is becoming increasingly attractive for cash generation in the high hills also (Pandey and Chaudhary, 2004).It is grown throughout the year in recent years in Nepal with the

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introduction of plastic house for off season production. It is grown from subsistence to commercial scale; and from the east to far west and terai to mid hill and mountain regions in Nepal. Earlier, tomato was used to be grown only in the rainy season in the hills at subsistence level only. With the introduction of improved varieties and plastic tunnel cultivation technology it has made it possible to grow in the spring season as well. Tomato is also most important vegetable crop and having high market potentialities, its cultivation has increased throughout the country. During cultivation and post-harvest storage, it is susceptible to more than 200 diseases (Ghimire *et al*., 2001) caused by an array of pathogenic fungi, nematodes, bacteria, and viruses. Although wide range of chemical pesticides are currently available to manage plant diseases, therefore a critical need of sustainable approach for the plant disease management is necessary.

Diseases not only cause yield and crop losses but also reduce quality of the produce there by affecting market value. Most of the diseases that affect tomatoes in Nepal are caused by various fungi, bacteria, viruses and nematodes. Diagnosis is the first step in disease management. Identification of the causal agent of the particular disease is very important factor for proper management of a problem. Study of the signs (the visible presence of a pathogen) and symptoms (a plant's reaction to infection with a pathogen) associated with the diseases is crucial. Many diseases of tomatoes occur both in the field and in enclosed structure (plastic tunnels); however, because of the unique nature and environmental conditions present in enclosed structures, some diseases are more common in those structures, whereas others are more common in the field. The trend of using plastic house for off season tomato production has been increasing. Though this practice needs higher investment, it also means higher profit due to higher yield and higher prices compared to open field cultivation. Cultivation of new hybrid varieties combined with improved technologies and plastic house technology which is one of the viable alternatives for quality tomato production in the high hills (Chapagain *et al*., 2010) has increased, manifold in tomato production. In another side, it has also been enhancing disease problems.

Currently Srijana is the dominating tomato due to hybrid in Nepal high yielding, longer shelf-life including consumers' preferable size as well as the taste. The farmers were also found using unregistered tomato varieties in the country. Late and early blight, root rot, septoria leaf spot, powdery mildew, bacterial wilt, bacterial stem rot and root-knot nematode are the major diseases of tomato reported in the country (PPD, 2017/19, 2018/19). Additionally, viral diseases are the major disease factor causing complete crop failure in many crop production systems (Hanssen *et al*., 2010). PPD (2017-19) has reported that tomato mosaic virus (ToMV), tomato yellow leaf curl virus (TYLCV) and cucumber mosaic virus (CMV) in tomato are the major virus diseases causing considerable yield losses. Regular monitoring of diseases is necessary for successful planning to manage the disease thereby minimizing the losses due to plant diseases. The objective of the study is to find out distribution of tomato diseases in the country and to explore new disease outbreak and to prioritize the important disease for research towards management.

MATERIALS AND METHODS

Tomato disease samples were either collected from different plastic tunnels and open field cultivation during survey and field visit or were received from different stakeholders who had brought for disease diagnosis under advisory services in the laboratory of Plant Pathology Division during 2074-2076. Among them 90% of received samples were from plastic tunnels and rest were from open fields. In total of 143 disease samples of tomato crops from various locations were received during fiscal year 2074-2076 (Table 1 and 2). The disease samples with whole information were collected such as their crop history on field distribution, year of crop cultivation, variety, previous crop, weather conditions, time of disease appearance, level of incidence and severity of disease, soil type, use of organic and inorganic manures and pesticides applications. The samples were categorized according to its causal organism group (fungal, bacterial, and viral and nematodes).

First of all, thorough study on the sign and symptoms of the samples was made, however, generally microscopic observation was used to confirm the pathogen associated with samples. Laboratory test was followed on those samples which could not be diagnosed from their sign and symptom. Based on the presumptive diagnosis with suspected pathogen through sign and symptoms study, the samples were processed for further steps.

For fungal diseases, the samples were placed in a moist chamber that provide enough humidity for the growth of the fungi associated with the diseased sample. Generally the moist chamber was created by placing moistened blotting paper on bottom of the petri-dish and a glass slide for the placement of the sample so that the sample could not have direct contact with the wet filter paper and get exposed to humid conditions (Mathur and Kongsdal, 2003). Plastic bags or boxes were used for larger samples. To discourage the growth of saprophytes present on the specimen or to kill them a brief surface sterilized with 70% isopropanol or ethyl alcohol or 1-2% sodium hypochlorite was done for 1-3 minutes based on the type of sample tissue. Then the sample pieces were dried under laminar flow and then placed on moist chamber. Moist chambers with sample were generally incubated at 22°C-24°C in incubator or at room temperature for 2-3 days. After incubation the samples were examined under stereomicroscope and compound microscope for growth habit and spore structure respectively and were identified with help of, disease compendium of APS, various books. Direct inspection, washing test, blotter test, Agar and selected media plate test and seedling test were common method used to diagnose fungal diseases.

For bacterial diseases diagnosis generally, ooze test was done along with symptomatology study and morphological test (Manandhar and Amatya, 1992).
Likewise, Dry seed inspection, seedling growing on test, indicator plant test, immune-stripe test and serological test (ELISA) were used for viral disease identification. Extraction and morphological identification methods were used for characterizing plant parasitic nematodes.

Table 1. Tomato samples collected/ received from different locations of the country during 2074-75

Disease	Number of samples	Districts/ Locations
Root /collar rot	5	Sarlahi (Lalbandi), Kavre (Nala), Nuwakot
Root rot	2	Kavre (Panauti, Nala), Lalitpur (Khumaltar)
Early Blight	15	Kathmandu (Baneshwor, Kirtipur, Pharping), Kavre (Deupur, Kuntabesi, Nala, Banepa), Dhading, Chitwan (Rampur), Lalitpur (Godawari, Luvu), Kaski (Hemja), Lamjung.
Late blight	6	Lamjung (Beshisahar), Kaski, Kavre (Panauti, Panchkhal), Lalitpur(Khumaltar)
Leaf spot	1	Dhading, Lamjung
Leaf Blight	1	Lalitpur (Thechui)
Powdery mildew	3	Lalitpur(Harisiddhi, Khumaltar)
Fruit blight	2	Kavre, Lalitpur (Thechu, Godawari)
Bacterial stem rot	6	Kavre (Panauti), Dhading, Lalitpur (Khumaltar),Kathmandu (Manahara)
Bacterial wilt	11	Kavre (Panauit), Lalitpur (Mahalaxmi), Dhading, Kathmandu (Mulpani, Manahara, Balkhu, Dahachowk)
TYLCV	6	Lalitpur (Luvu, Dholahity), Kathmandu (Pharping), Kaski (Hemja)
CMV	9	Kavre (Dhulikhel, Panauti, Panchkhal), Bara (Parwanipur), Lalitpur (Harisiddhi, Jharuwarashi, Luvu, Dholahity), Dhading (Khanikhola), Kaski (Malepatan,Lumle), Nuwakot
ToMV	19	Kavre (Panchkhal, Kharelthok,Nala, Banepa), Kathmandu (Thankot), Bara (Parwanipur), Lalitpur (Luvu,Dholahity, Harisiddhi, Tikathali), Dhading (Khanikhola), Sindhupalchowk, Kaski (Hemja, Lumle)
Root-knot nematode	7	Kathmandu (Kirtipur,Pharping), Lamjung, Kaski,Dhading,Kavre (Panchkhal), Lalitpur(Harisiddhi, Taukhel)
14	**92**	**12**

Table 2. Tomato sample collected/received from different location of the country during 2075-76.

Disease	Number of sample	Location
Root /collar rot	2	Lalitpur (Godawari, Chunikhel)
Root rot	5	Sunsari (Tarahara), Kathmandu (Dahachowk, Narayanthan), Lalitpur (Chapagaun)
Early blight	9	Nuwakot, Kathmandu (Balaju), Dhading (Bisaltar), Sunsari (Tarhara), Parsa, Chitwan, Lalitpur (Luvu, Lele, Chapagaun, Dhapakhel)
Late blight	4	Lalitpur (Khumaltar, Harisiddhi, Loobhu, Chapagaun)
Leaf spot	2	Lalitpur (Godawari), Kathmandu (Balaju), Lamjung
Fruit blight	1	Lalitpur (Khumaltar), Kathmandu (Thankot)
Powdery mildew	5	Lalitpur (Godawari, Mahalaxmi, Tikathali, Khumaltar), Kathmandu (Kamalpokhari)
Bacterial wilt	5	Lalitpur (Dhapakhel, Khumaltar), Bhaktapur (Jhaukhel), Kathmandu (Dasksinkali, Mulpani, Sundarijal)
Bacterial stem rot	6	Lalitpur (Chapagaun, Chunikhel), Kathmandu (Thankot)
Pith necrosis	1	Lalitpur (Dhapakhel)
ToMV	16	Kathmandu (Mulpani, Manahara, Kageshwori), Lalitpur (Mahalaxmi, Luvu, Chapagaun, Godawari, Tikathali, Changathali, Khumaltar), Sunsari, Lamgung
CMV	4	Kathmandh (Mulpani), Lalitpur (Mahalaxmi, Luvu, Tikathali, Changathali)
Root knot nematode	1	Bhaktapur (Jhaukhel)
13	**51**	**12**

RESULTS AND DISCUSSION

Out of 143 samples for disease diagnosis, 53 (37%) was diagnosed as fungal infection, 28 (20%) as bacterial infection, 54 (37%) as viral infection and 8 (6%) as nematode infection. Agreeing 90% of plastic tunnel samples, the infection of fungal as well as viral diseases were equally diagnosed.

Fifty-three fungal disease samples were detected from eleven districts in which Kathmandu, Lalitpur, Bhaktapur, Kavre, Sarlahi, Dhading, Nuwakot, Chitwan, Kaski, Lamjung and

Sunsari. The major fungal pathogens associated with various diseases as identified were root/collar rot (*Rhizoctonia solani* and *Fusarium* sp.), leaf spot (*Septoria lycopersici*), early leaf blight (*Alternaria solani*), late blight (*Phytopthora infestans*) and powdery mildew (*Leveillula taurica*) were identified (Table 3).

Twenty-eight bacterial disease samples were collected/received from five districts. Those districts were Kathmandu, Lalitpur, Bhaktapur, Kavre and Dhading. The bacterial diseases as identified with their causal bacterium were bacterial wilt (*Ralstonia solanacearum*), pith necrosis (*Pseudomonas corrugata*) and bacterial stem rot (*Eriwinia carotovora*) (Table 4).

Similarly, fifty-four viral disease samples were detected from ten districts which were Kathmandu, Lalitpur, Kavre, Bara, Dhading, Sindhupalchowk, Kaski, Nuwakot, Sunsari and Lamjung. ToMV (Tomato mosaic virus), CMV (Cucumber mosaic virus) and TYLCV (Tomato yellow leaf curl virus) diseases were the identified virus diseases (Table 5).

Eight nematode disease samples were from six districts, those were Kathmandu, Lalitpur, Bhaktapur, Dhading, Kavre and Lamjung. The nematode disease as identified was root knot caused by (*Meloidogyne* sp.) (Table 6).

Table 3. List of fungal diseases of tomato detected from different location during 2074-76

Disease	Causal organism	2074/75		2075/76	
		No. of sample	Location of occurrence Districts and places	No. of sample	Districts
Root rot	*Fusarium* sp.	2	Kavre (Panauti, Nala), Lalitpur (Khumaltar)	5	Sunsari (Tarahara), Kathmandu (Dahachowk, Narayanthan), Lalitpur (Chapagaun)
Root/ collar rot	*Rhizoctonia* sp.	5	Sarlahi(Lalbandi),Kavre (Nala), Nuwakot	2	Lalitpur (Godawari, Chunikhel)
Leaf blight	*Fulvia fulva*	1	Lalitpur (Thecho)	0	-
Early blight	*Alternaria solani*	15	Kathmandu (Baneshwor, Kirtipur, Pharping), Kavre (Deupur, Kuntabesi, Nala, Banepa), Dhading, Chitwan (Rampur), Lalitpur (Godawari,, Luvu), Kaski (Hemja), Lamjung.	0	-

Disease	Causal organism	2074/75		2075/76	
		No. of sample	Location of occurrence Districts and places	No. of sample	Districts
Fruit blight	*Cladosporium* sp.	0	-	1	Lalitpur (Khumaltar), Kathmandu (Thankot)
Leaf spot	*Septoria* sp.	1	Dhading	2	Lalitpur (Godawari), Kathmandu (Balaju)
Powdery mildew	*Leveillula taurica*	3	Lalitpur (Khumaltar, Harisiddhi, Dhapakhel)	5	Lalitpur (Godawari, Mahalaxmi, Tikathali, Khumaltar), Kathmandu (Kamalpokhari)
Late blight	*Phytophthora infestans*	6	Lamjung (Beshisahar), Kaski, Kavre (Panauti, Panchkhal), Lalitpur(Khumaltar)	4	Lalitpur (Khumaltar, Harisiddhi, Luvu, Chapagaun)

Table 4. List of bacterial diseases of tomato detected from different location during 2074-76

Disease	Causal organism	2074/75		2075/76	
		No. of sample	Location of occurrence Districts and places	No. of sample	Districts
Bacterial wilt	*Ralstonia solanacearum*	10	Kavre (Panauti), Lalitpur (Mahalaxmi), Dhading, Kathmandu (Mulpani, Manahara, Balkhu, Dahachowk	5	Lalitpur (Dhapakhel, Khumaltar), Bhaktapur (Jhaukhel),Kathmandu (Dasksinkali, Mulpani, Sundarijal)
Bacterial stem rot	*Erwinia carotovora*	6	Kavre (Panauti), Dhading, Lalitpur (Khumaltar), Kathmandu (Manahara)	6	Lalitpur (Chapagaun, Chunikhel), Kathmandu (Thankot)
Pith necrosis	*Pseudomonas corrugate*	-	-	1	Lalitpur (Thecho)

Table 5. List of viral diseases of tomato detected from different location during 2074-76

Disease	Causal organism	2074/75		2075/76	
		No. of sample	Location of occurrence Districts and places	No. of sample	Districts
ToMV	Tomato mosaic virus	19	Kavre (Panchkhal, Kharelthok, Nala, Banepa), Kathmandu (Thankot), Bara (Parwanipur) Bara, Lalitpur (Luvu,Dholahity, Harisiddhi, Tikathali), Dhading (Khanikhola), Sindhupalchowk, Kaski (Hemja, Lumle)	16	Kathmandu (Mulpani, Manahara, Kageshwori), Lalitpur (Mahalaxmi, Luvu, Chapagaun, Godawari, Tikathali, Changathali, Khumaltar), Sunsari, Lamjung
Virus (CMV)	Cucumber mosaic virus	9	Kavre (Dhulikhel, Panauti, Panchkhal), Bara (Parwanipur), Lalitpur (Harisiddhi, Jharuwarashi, Luvu, Dholahity), Dhading (Khanikhola), Kaski (Malepatan, Lumle), Nuwakot	4	Kathmandh (Mulpani), Lalitpur (Mahalaxmi, Luvu, Tikathali, Changathali)
Virus (TYLCV)	Tomato yellow leaf curl virus	6	Lalitpur (Luvu, Dholahity), Kathmandu (Pharping), Kaski (Hemja)	0	-

Table 6. List of nematode diseases of tomato detected from different location during 2074-76

Disease	Causal organism	2074/75		2075/76	
		No. of sample	Location of occurrence Districts and places	No. of sample	Districts
Root-knot nematode	*Meloidogyne* sp.	7	Kathmandu (Kirtipur, Pharping), Lamjung, Kaski, Dhading, Kavre (Panchkhal), Lalitpur (Harisiddhi, Taukhel)	1	Bhaktapur (Jhaukhel)

Diseases caused by fungus, nematodes, bacteria, and viruses are of the most severe concern in tomato crops (plastic tunnels and open field), which not only affect their nutritional contents, but also human health and overall economy of the growers. The disease samples collected during survey and field visits or received at Plant Pathology Division laboratory Khumaltar, Lalitpur, NARC under the advisory services for their management were diagnosed and identified their causal organisms or the pathogens. Different diseases certainly cause loss in production directly or indirectly. Some of the most important diseases

in tomato caused by fungal pathogens were late and early blight which are one of the most destructive diseases of tomato resulting in significant economic loss with 14.3% of total disease diagnosed. Likewise, fusarium wilt, rhizoctonia crown, and root rot is another one of the important diseases affecting the tomato crop productivity. Root-knot caused by the nematode *Meloidogyne* sp. is the other most devastating and widespread disease in tomato. Nematode not only affects the crop yield directly but also makes the plants more susceptible to fungal and bacterial infections (Ashraf and Khan 2010). The most economically and scientifically important species due to their intricate relationship with the host plants, wide host range, and the level of damage ensued by infection. Cultivation of the use of chemical pesticides has brought increasing interest in studies on alternative methods of nematode control. However, efficient control measures have yet been developed. *Ralstonia solanacearum* is the most important soil-borne plant pathogens that cause bacterial wilt in over 200 families of plants, including tomatoes and hampers their production (Huang *et al*., 2013). In recent years, bacterial stem rot (*Ewrinia carotovora*) infected on the stem causing substantial economic loss in tomato production. It is highly destructive in both plastic house as well as in field conditions. Viral disease of tomato includes tomato mosaic virus, cucumber mosaic virus and tomato yellow leaf curl virus are the most important viral diseases of cultivated tomato in the tropical and subtropical regions which occasionally lead to plant death Syndrome caused by fungi, bacteria, viruses, nematodes and other pathogens are the major production constraints causing both qualitative and quantitative losses of tomato yields every year. Direct losses are caused by both quantitative and qualitative yield reductions. Indirect losses are due to control measures and to the quarantine status. As the PPD is primarily concern with researches on different aspects, agriculture scientists, it is big challenge as well as opportunities for them. Solving disease problems can play one of the important parts in improving crop yield to the benefit of commercial and subsistence farms, and the consumers. Even though, having the limited outreach trials and experiments in those areas; nevertheless, its extension and adoption was found slowly increasing.

CONCLUSION

Tomato farming under plastic tunnel is one of the major sources of income to most of the farmers as a result of by receiving many samples of tomato in all season in PPD laboratory during 2074-2076. It is concluded that farmers were still facing various constraints associated with disease problems. Virus diseases are increasing to meet as equal as fungal diseases. Diagnosis and identification of their causal organism is one of the most important first step for the management of any disease. Regular monitoring of pathogen is necessary for exploring new disease outbreak as well as for successful planning to manage the disease in tomato crops to minimize the losses due to plant diseases. However, to figure out the tomato disease distribution in the country locations covered in the study are not enough.

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