An overview of bacterial diseases of the most important agricultural crops in Nepal

Jay Ram Lamichhane, Giorgio M. Balestra, Angelo Mazzaglia, Mb Kshetri, Leonardo Varvaro

An Overview on Bacterial Diseases of the Most Important Agricultural Crops in Nepal

J.R. Lamichhane[1,2], G.M. Balestra[1,2], A. Mazzaglia[1] M.B. Kshetri[2] and L. Varvaro[1,2]
[1] Dipartimento di Protezione delle Piante, Facoltà di Agraria, Università degli Studi della Tuscia, 01100, Viterbo, Italy
[2] Central Horticulture Centre, Kirtipur, Kathmandu, Nepal

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Abstract

Several surveys were carried out during three consecutive years (2007-2009) on the major crops cultivated in different districts of Nepal, in order to verify the possible presence of diseases caused by bacteria. The monitoring was carried out twice a year, in spring and autumn. During the survey we observed a wide range of bacterial diseases of plants. Most of the diseases were observed for the first time while others had been reported previously. Among the bacterial diseases observed for the first time, the most important were olive knot, bacterial speck of tomato, crown gall of plum, soft rot of potato, bacterial spot of tomato, and bacterial spot of cucurbits. Outbreaks of black rot were observed in different *Brassica* fields. Among the other widespread diseases, the most important were bacterial leaf blight of rice, citrus canker, citrus greening, bacterial wilt of tomato, potato, pepper, and eggplant, halo blight of bean, and bacterial pustule and bacterial blight of soybean. Attempts to explore the source of introduction of these pathogens, their spread, and yield losses caused were made together with recommendations for control measures.

INTRODUCTION

Agriculture in Nepal has long been based on subsistence farming, particularly in the hilly regions where peasants derive their living from fragmented plots of land cultivated in difficult conditions. Only 30% of the total land in Nepal is cultivated since the major part of the land is occupied by mountains and hills. For this reason, almost all the harvested crops are aimed at family use and farmers only export some surplus which is the main source of their income (Schroeder, 1985). The main cultivated plants are represented by rice, 1.5 million ha, followed by wheat and maize, which together take up a similar portion of the cultivated land, and thirdly by cash crops (sugarcane, oilseed, tobacco, and vegetables) that are very important for Nepalese farmers because of the good economic returns.

Agricultural crops are threatened by a wide variety of pathogens and pests all over the world. Several studies have been made in developed countries to find out the relationship between the presence of the plant pathogens and the potential yield losses caused by them. Nevertheless, very little is known about the plant diseases and yield losses in Nepal, in particular, those caused by the bacterial pathogens, since very few studies have been carried out until recently. Moreover, comparison of the average yield of plant crops with other developed and developing countries shows a big gap between potential yield and actual yield of Nepalese farmers (FAO, 2008). This low productivity is associated with a number of reasons. Among them, plant diseases are the most important factors.

Our aim was to carry out a wide survey to verify whether there are new plant diseases, and to provide complete information on their control using effective measures, on the most important agricultural plants cultivated in Nepal. Our study focused mainly on the vegetable crops since these are considered important cash crops due to the fact that their cultivation in many areas of Nepal is almost continuous, with up to three crops per year (Anonymous, 2006).

MATERIALS AND METHODS

Surveyed Zones and Plant Species

Many commercial fields and home gardens were surveyed in all the three major agricultural zones (high hills, mid hills, and plain land) of Nepal. The plant species surveyed and districts where we carried out the investigations are shown in Table 1.

Collection of Infected Plants and Bacterial Identification

During the survey, only plants showing characteristic bacterial disease symptoms were considered. The diseased parts of the plants were aseptically collected, put into sterile laboratory bags, and taken immediately to the laboratory and stored at 4°C. Within two days of sampling, bacteria were isolated from the diseased tissues on to selective or semi-selective media and incubated at 26±1°C to determine the possible causal agents. After 48-72 h, single bacterial colonies were purified. Identification of the bacterial isolates was made by morphological, physiological, biochemical, molecular, and pathogenicity tests.

Determination of Disease Incidence and Yield Loss

The number of surveyed fields and the presence of given diseases in those fields was taken into account. Disease incidence was calculated as the ratio between the number of surveyed fields and the number of fields where a given disease was found. The yield losses caused by the bacterial pathogens were calculated by the relationship between the average potential yield of a certain field from a given zone in the absence of the disease and that effectively obtained from a field where disease was present (Burlakoti and Khatri-Chhetri, 2004) (Table 2).

Collection of Information on Diseases Previously Reported

Besides our study, information was collected on the bacterial diseases previously found and reported by other authors and is shown in Table 3.

RESULTS

Surveyed Districts and Plant Species

Surveys were carried out in districts particularly important for different plant cultivation. In many cases, attention was paid to particular districts based on information provided by previous authors for the phytobacteriological investigation (Table 1).

Collection of Infected Plants and Bacterial Identification

During the surveys, characteristic symptoms of bacterial diseases were observed in all the districts where investigations were made (Table 2), except in some districts where the presence of the diseases was not verified (Fig. 1). The assays performed for the identification of the pathogens are listed in Table 4.

CONCLUSIONS

In the present study we report a wide range of bacterial diseases of plants for the first time in Nepal such as olive knot, bacterial speck of tomato, crown gall of plum, soft rot of potato, bacterial spot of tomato, and bacterial spot of pumpkin. On the other hand, this study supports previous findings confirming that bacterial diseases are widespread in different districts of the country and are becoming a serious problem.

The presence of the newly reported diseases indicates the possible introduction of the bacterial pathogens via infected seed, transplants, and other vegetative materials used for plant propagation from other countries, including those neighbouring countries where these pathogens have been widely reported. The considerable economic losses caused by these diseases and their wide host range represent a serious concern for an undeveloped country like Nepal where the role of agriculture is of fundamental importance since it is a

main source of income. The control measures of quarantine pest and disease management, and the agronomical and cultural practices for disease prevention within the country are not effective and targeted to disease control. Therefore, the introduction of new plant pathogens into the country and the spread of those already present from one region to another occur continuously and can be a serious threat for Nepalese agriculture.

Only some bacterial diseases such as bacterial blight of rice (Adhikari and Mew, 1988; Adhikari and Shrestha, 1989; Adhikari et al., 1996, 1999a,b), black rot of *Brassica* (Adhikari and Basnyat, 1999; Jensen et al., 2010; Shakya et al., 2000; Shrestha, 1997; Shrestha and Mathur, 1977), and bacterial wilt of potato (Pradhanang et al., 1993, 2000; Pradhanang and Elphinstone, 1996; Shrestha, 1977; Shrestha et al., 1977), have been an important focus of study by many authors who provided detailed information on the disease severity, yield loss, spread, and the diversity of the bacterial pathogens. Either no or limited attention has been paid to other bacterial pathogens, in particular the bacterial pathogens of those vegetable crops which represent important cash crops for the livelihood of Nepalese farmers (Burlakoti and Khatri-Chhetri, 2004; Subedi and Khattri-Chettri, 2004).

Our study confirms that the average disease incidence and yield losses caused by bacterial pathogens in Nepal are very high. For this reason, immediate control measures are necessary to avoid the spread of bacterial pathogens from one region to another, and to eradicate them from districts where the diseases are threatening agricultural production. Nevertheless, there are many areas of the country that still need to be surveyed for the presence of bacterial pathogens and may provide several new findings. A thorough study will be needed to collect detailed information that will be helpful for future research on bacterial diseases of crop plants in Nepal.

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Tables

Table 1. List of surveyed plant species and districts.

Crop	Surveyed districts
Brassica vegetables*† (cabbage, cauliflower and broccoli)	Bhaktapur, Lalitpur, Chitwan, Dhankuta, Baglung, Nuwakot, Kathmandu, Makwanpur
Potato*†	Kathmandu, Nuwakot, Bhaktapur, Lalitpur, Kaski
Tomato*†	Kathmandu, Lalitpur, Banke
Pumpkin*	Kathmandu, Lalitpur, Bhaktapur
Bean*†	Kathmandu, Dhading
Soybean*†	Nuwakot, Kathmandu
Pepper*†	Kathmandu, Nuwakot, Bhaktapur, Lalitpur, Kaski
Eggplant*†	Kathmandu, Nuwakot, Bhaktapur, Lalitpur, Kaski
Rice*†	Ilam, Jhapa, Dhankuta, Bhojpur, Sunsari, Dhanusha, Sarlahi, Makwanpur, chitwan, Bara, Parsa, Palpa, Gulmi, Kaski, Lamjung, Tanahu, Gularia, Dang, Pyuthan, Nuwakot
Maize*†	Kathmandu, Nuwakot, Bhaktapur, Lalitpur, Kaski
Pea*†	Chittwan, Nuwakot, Bhaktapur, Lalitpur, Kaski
Plum*	Kathmandu, Nuwakot, Gorkha
Citrus*†	Kathmandu, Nuwakot, Gorkha, Kavre, Kaski, Sindhuli
Olive*	Bajura, Mugu, Dolpa, Kathmandu, Makwanpur

*these studies; †previous studies.

Table 2. Incidence of bacterial diseases of plants in the surveyed districts.

Disease	Causal bacterial agent	Incidence
Black rot of *Brassica* spp.	*Xanthomonas campestris* pv. *campestris*	High
Soft rot of potato	*Pectobacterium carotovorum*	Medium
Bacterial wilt of potato	*Ralstonia solanacearum*	Medium
Bacterial speck of tomato	*Pseudomonas syringae* pv. *tomato*	Low
Bacterial spot of tomato	*Xanthomonas campestris* pv. *vesicatoria*	Low
Bacterial wilt of tomato	*Ralstonia solanacearum*	Very high
Bacterial spot of pumpkin	*Xanthomonas campestris* pv. *cucurbitae*	Low
Bacterial wilt of eggplant	*Ralstonia solanacearum*	Medium
Bacterial wilt of pepper	*Ralstonia solanacearum*	High
Common blight of bean	*Xanthomonas campestris* pv. *phaseoli*	Medium
Halo blight of bean	*Pseudomonas syringae* pv. *phaseolicola*	Medium
Bacterial blight of soybean	*Pseudomonas syringae* pv. *glycinea*	Medium
Bacterial pustule of soybean	*Xanthomonas campestris* pv. *glycines*	Medium
Bacterial blight of pea	*Pseudomonas syringae* pv. *pisi*	Medium
Bacterial blight of rice	*Xanthomonas orizae* pv. *orizae*	High
Crown gall of plum	*Agrobacterium tumefaciens*	High
Olive knot	*Pseudomonas savastanoi* pv. *savastanoi*	Low
Citrus canker	*Xanthomonas campestris* pv. *citri*	Very high
Citrus greening	*Liberobacter asiaticum*	Very high
Bacterial wilt of tobacco	*Ralstonia solanacearum*	High
Bacterial stalk rot of maize	*Erwinia chrysanthemi*	high

Low: <20%; medium: <20-40%; high: 40-60%; very high: >60%.

Table 3. List of reported disease and yield loss caused by the pathogens.

Disease	Reference	Average yield loss (%)
Black rot of brassica	Shrestha and Mathur, 1977	40
Soft rot of potato	Lamichhane et al., 2010	20
Bacterial wilt of potato	Shrestha, 1977	75
Bacterial speck of tomato	Lamichhane et al., 2009	18
Bacterial spot of tomato	Lamichhane et al., 2010	25
Bacterial wilt of tomato	Adhikari et al., 1993	90
Bacterial wilt of eggplant	Adhikari et al., 1993	32
Bacterial wilt of pepper	Adhikari et al., 1993	90
Bacterial spot of pumpkin	Lamichhane et al., 2010	12
Common blight of bean	OEPP/EPPO, 1978	16
Halo blight of bean	Burlakoti and Khatri-Chhetri, 2004	16
Bacterial blight of pea	OEPP/EPPO, 1978	13
Bacterial blight of soybean	Burlakoti and Khatri-Chhetri, 2004	16
Bacterial pustule of soybean	Burlakoti and Khatri-Chhetri, 2004	23
Bacterial blight of rice	Adhikari and Mew, 1988	32
Crown gall of plum	Lamichhane et al., 2009	60
Olive knot	Balestra et al., 2009	25
Citrus canker	OEPP/EPPO, 1990	90
Citrus greening	Regmi and Lama, 1988	92
Bacterial wilt of tobacco	Adhikari et al., 1993	35
Bacterial stalk rot of maize	Burlakoti and Khatri-Chhetri, 2004	75

Table 4. List of assays used for the identification of bacterial species.

Morphological and cultural	Physiological and biochemical
Form	Levan production
Colony colour	Fluorescence test
Colony margin	Oxidase production
Colony dimension	Potato soft rot
Molecular	Arginine hydrolysis
16SrDNA	Aesculin hydrolysis
Pathogenicity test	H_2S production
In vivo - by using a bacterial suspension containing 10^8 CFU/ml	Carbon source utilization
	Phosphatase test
	Gram test

Figures

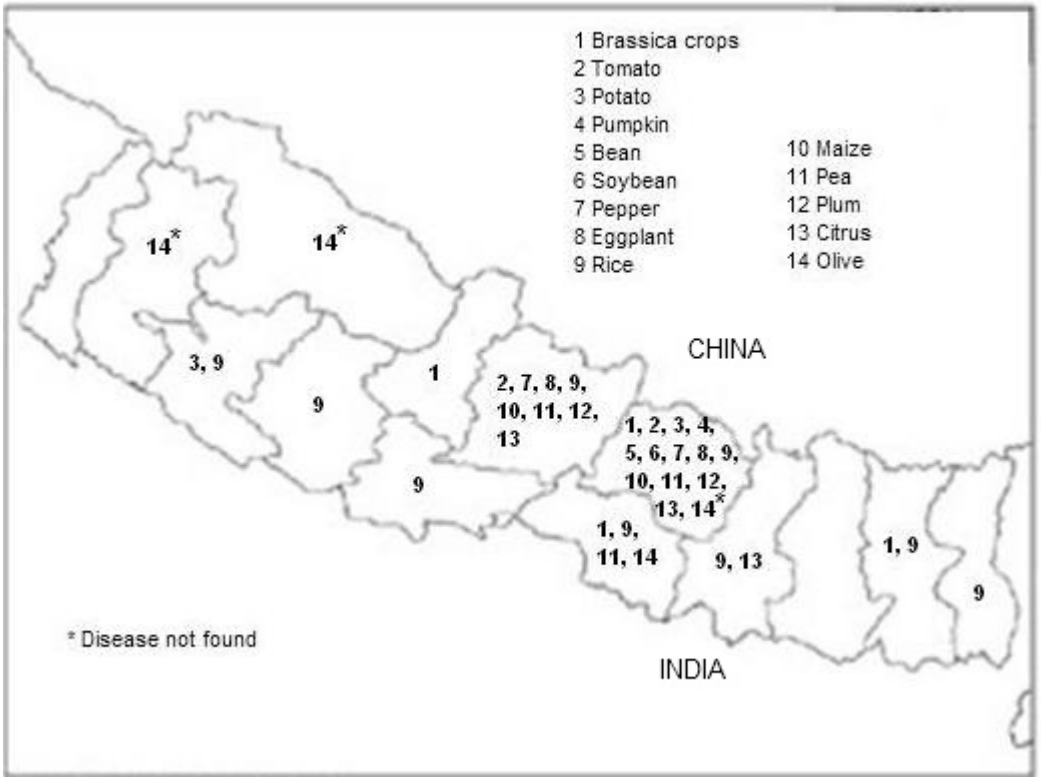

Fig. 1. Map of surveyed zones and plant species.

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