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Crop and weed host of *Ralstonia solanacearum* in West Bengal

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ABSTRACT

Bacterial wilt caused by Ralstonia solanacearum (Smith) Yabuuchi et al. is prevalent in West Bengal. During the surveys in West Bengal from 2005 to 2010 it was found to cause extensive damage to crops like brinjal, tomato, potato, marigold, chilli, tobacco, elephant foot yam, bottle gourd, water melon, banana, jute, ginger, large cardamom, Cestrum nocternum and Bougainvillea sp. including twelve wild plants viz. Croton sparsiflorus, Cestrum diurnum, Solanum indicum, Solanum sisymbriifolium, Physalis minima, Amaranthus spinosus, Amaranthus viridis, Datura metel, Malachra capitata, Melochia corchorifolia, Pennisetum purpureum and Costus speciosus. Percent disease incidence was recorded from 1.09 to 91.85 in crop plants whereas, wild plants harbour this menacing pathogen in off-season and serve as collateral hosts effectively. Isolates of R. solanacearum from brinjal, tomato, potato, marigold, jute, chilli and eight wild plants i.e. Croton sparsiflorus, Cestrum diurnum, Solanum indicum, S. sisymbriifolium, Physalis minima, Amaranthus spinosus, A. viridis and Datura metel were found to be pathogenic on tomato and brinjal. But the isolates of ginger, elephant foot yam and the wild host Costus speciosus belonged to same group and were pathogenic on these three hosts only.

Key words: Bacterial wilt, host range, *Ralstonia solanacearum*, weed host

In India the first report of bacterial wilt disease was made by Chappel in 1892 and in West Bengal by Hutchinson 1913 (Butler, 1903; Kelman, 1953). Afterwards several workers reported the occurrence of this devastating disease (Das and Chattopadhyay, 1955; Mukherjee and Chattopadhyay, 1955; Chattopadhyay and Mukherjee, 1968; Sharma and Mukherjee, 1970; Chatterjee, 1996; Mondal *el al.*, 2004). More than 200 plant species under 55 families have been reported as hosts of *Ralstonia solanacearum* (Smith) Yabuuchi (Kelman, 1953; Hayward, 1994). Weed hosts of *R. solanacearum* had already been reported from different parts of the globe. Some weed hosts of this pathogen were also reported from India (Chaudhuri and Khatua, 1982; Chatterjee, 1996; Samaddar *et al.*, 1998; Mondal *et al.*, 2005). Wide host range of the pathogen has increased the survival potential of the pathogen. The survival of the pathogen in weed hosts may be one of the reasons for the devastation of this disease in West Bengal. During last three decades, the situation in agriculture has changed to a great extent. This change is related to higher cropping intensity, varietal replacement and intensive use of manures, fertilizers and pesticides in the dynamic agricultural system. Under the changing agro-ecological situation, there is no clear cut picture regarding the damage or crop loss caused by bacterial wilt disease. To understand the disease scenario, survey was conducted throughout West Bengal in several seasons (2005-2010) to record the occurrence and seasonal incidence of the bacterial wilt in different crops including weed hosts.

MATERIALS AND METHODS

Survey of bacterial wilt disease

Surveys were conducted in twelve districts (Table 1) of West Bengal during 2005-2010 to record the intensity of Bacterial wilt disease caused by *Ralstonia solanacearum*. Multistage stratified random sampling was employed during surveys. Incidence of the disease on crop plants was recorded during cropping season of a particular crop. Percent disease incidence was calculated involving all the plants in a particular affected field. Incidence of the disease on weed hosts in and around the crop fields was recorded in every month.

Confirmation of the identity of the bacterium

Bacterial nature of the disease was confirmed by ooze test, isolation in selective medium (Granada and Sequeira, 1983), through morphological and bio-chemical studies and pathogenicity test by stem injection and root inoculation method (Kelman, 1953; Kelman, 1954; Hayward, 1964).

RESULTS AND DISCUSSION

Crop hosts of *Ralstonia solanacearum* in West Bengal

Brinjal, tomato and potato were affected by the disease throughout West Bengal and percentages of damage were 9.68 to 86.45, 10.54 to 85.63 and 10.72 to 73.82 respectively (Table 1.). Brinjal and tomato transplanted during summer months are more liable to be infected with this disease than those transplanted in the relatively cooler part of the year. Wilting was generally observed in the reproductive stages of the crop growth. The maximum disease intensity was recorded during August – September in brinjal and January – February in tomato. Potato seed tubers which were sown during cool season have been found less vulnerable to this disease. Bacterial wilt of potato was observed in the early growth or during tuberization and continued up to crop maturity. The disease was recorded during November to February.

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Table 1: Crop plants affected by bacterial wilt in West Bengal

Sl. No.	Name of the crop	Family	Recorded from	% disease incidence
1.	Brinjal (*Solanum melongena* L.)	Solanaceae	Twelve districts of West Bengal*	9.68 – 86.45
2.	Tomato (*Lycopersicpn esculentum* Mill.)	Solanaceae	Twelve districts of West Bengal	10.54 – 85.63
3.	Potato (*Solanum tuberosum* L.)	Solanaceae	Twelve districts of West Bengal	10.72 – 73.82
4.	Marigold (*Tagetes erecta* L.)	Asteraceae	Purba and Paschim Medinipur, North and South 24 Parganas, Nadia, Birbhum	2.76 – 62.23
5.	Chilli (*Capsicum annuum* L.)	Solanaceae	North and South 24 Parganas, Nadia, Birbhum, Murshidabad	4.54 – 64.06
6.	Tobacco (*Nicotiana rustica* L. and *Nicotiana tabacum* L.)	Solanaceae	Coochbehar, Jalpaiguri, Maldah, Nadia	1.09 – 12.78
7.	Elephant Foot Yam (*Amorphophallus campanulatus* Blume)	Areceae	South and North 24 Parganas, Nadia	5.95 – 66.67
8.	Bottle gourd (*Lagenaria siceraria* (Molina) Standl.)	Cucurbitaceae	North 24 Parganas	4.50
9.	Water melon (*Citrullus lanatus* (Thunb.) Matsumura & Nakai)	Cucurbitaceae	Purba Medinipur, Coochbehar	20.00 – 30.00
10.	Banana (*Musa paradisiaca* L.)	Musaceae	Hooghly, Nadia, South and North 24 Parganas, Coochbehar	20.32 – 30.98
11.	Jute (*Corchorus olitorius* L.)	Tiliaceae	North 24 Parganas Hoogly,Jalpaiguri, Coochbehar	2.00– 15.00
12.	Ginger (*Zingiber officinale* Rosc.)	Zingiberaceae	South and North 24 Parganas, Nadia, Paschim Medinipur, Birbhum, Coochbehar, Jalpaiguri, Darjeeling	10.71 – 91.85
13.	Large cardamom (*Amomum subulatum* Roxb.)	Zingiberaceae	Jalpaiguri and Darjeeling	4 .00– 20.00
14.	Hasnuhana (*Cestrum nocturnum*)	Solanaceae	Nadia	10.71
15.	*Bougainvillea* sp.	Nyctaginaceae	Nadia	10.00

*Note: *Birbhum, Coochbehar, Darjeeling, Hooghly, Jalpaiguri, Maldah, Murshidabad, Nadia, North 24 Parganas, Paschim Medinipur, Purba Medinipur, South 24 Parganas*

Wilting of chilli (4.54 to 64.06%) was recorded in North and South 24 Parganas, Nadia, Birbhum and Murshidabad. In this case, plants showed total wilting and wilted plants respond to ooze test. The symptom was recorded during November to April in chilli. Bacterial wilt of elephant foot yam was observed from the districts of South 24 Parganas, North 24 Parganas and Nadia. Percentage of wilting varied from 5.95 to 66.67%. The elephant foot yam has been found infected in the field during July to October. Disease on marigold was recorded from Purba Medinipur, Paschim Medinipur, Birbhum, North 24 Parganas, South 24 Parganas, and Nadia (2.76 to 62.23%), and was particularly prevalent in pre-winter season. Bacterial wilt of ginger was observed from Darjeeling, Jalpaiguri, Coochbehar, Birbhum, Paschim Medinipur, Nadia, South and North 24 Parganas (10.71 to 91.85%) districts. The disease initiates from July and continued up to November with a pick of August – September in plain of West Bengal. During survey some other crops have also been found to be infected with this bacterium. These were, Olitorious jute from North 24 Parganas, Hoogly, Jalpaiguri and Coochbehar (2 to 15%); banana from Hooghly, Nadia, South 24 Parganas, North 24 Parganas and Coochbehar (20.32 to 30.98%); tobacco from Coochbehar, Jalpaiguri, Maldah and Nadia (1.09 to 12.78%); water melon from Purba Medinipur and Coochbehar (20-30%); bottle gourd from North 24Pargana (4.5%); large cardamom from Jalpaiguri and Darjeeling (4-20%); *Cestrum nocturnum* (10.71%) and *Bougainvillea* sp. (10%) from Nadia (Table 1). Marigold is grown in some pockets of West Bengal as a commercial ornamental crop. This crop suffers severely after the rainy season when the temperature is considerably high. Present study confirmed the incidence of the disease in triploid banana (var. Kancha Kala, Martaman, Giant Governor, Champa). This finding is corroborated with the earlier workers (Chatterjee *et al.*, 1997). Planting of infected seed rhizome of ginger in the plains as well as cultural practice like removal

of seed rhizome after establishment of the plant in hills accelerated the problem of wilting and rhizome rot. Similarly, desuckering helped in rapid spread of the disease in banana orchard. Bacterial wilt pathogen introduced in the field through potato tuber but in case of brinjal and tomato the disease originates from inoculum present in the soil or infected transplant. Among the cultivated solanaceous vegetables, chilli was found less affected to this disease. Incidence of the disease in wide variety of crops and its occurrence throughout the year posed an alarming situation in West Bengal.

Weed hosts of *Ralstonia solanacearum* in West Bengal

During the surveys, wilting of *Croton sparsiflorus, Cestrum diurnum, Solanum indicum, S. sisymbriifolium, Physalis minima, Amaranthus spinosus, A. viridis* and *Datura metel* were recored in different parts of the state (Table 2). These plants are usually found in non-crop areas such as roadside, barren lands, ridges of the field, fallow lands and in and around the fruit orchard and vegetable field. *Cestrum diurnum* and *Costus speciosus* were found to grow widely in some areas of Nadia, North 24-parganas, South 24 Parganas, Hooghly and Medinipur district

Table 2: Common weeds affected by bacterial wilt in West Bengal

Sl. No.	Name of the plant	Botanical family	Recorded from
1.	*Croton spersiflorus*	Euphorbiaceae	Purba and Paschim Medinipur, Coochbehar, Nadia, North and South 24 Parganas
2.	*Cestrum diurnum*	Solanaceae	Nadia, North 24 Parganas, Hooghly
3.	*Solanum indicum*	Solanaceae	Nadia, North and South 24 Parganas
4.	*Solanum sisymbriifolium*	Solanaceae	Nadia, North and South 24 Parganas
5.	*Physalis minima*	Solanaceae	Nadia, North and South 24 Parganas
6.	*Amaranthus spinosus*	Amaranthaceae	Nadia, North and South 24 Parganas
7.	*Amaranthus viridis*	Amaranthaceae	Nadia, North and South 24 Parganas
8.	*Datura metel*	Solanaceae	Nadia, North 24 Parganas
9.	*Malachra capitata*	Malvaceae	Nadia
10.	*Melochia corchorifolia*	Sterculiaceae	Nadia
11.	*Pennisetum purpureum*	Graminae	Nadia
12.	*Costus speciosus*	Zingiberaceae	Nadia, Purba and Paschim Medinipur, North and South 24 Parganas

In most of the weeds wilting process started from the last week of February to first week of March (mean Tmax. 28°C and Tmin. 20°C) when temperature gradually rises. The maximum wilt intensity was recorded during August-September (mean Tmax. 30°C and Tmin. 26°C) and death of such plants ceased at the end of October (mean Tmax.29^{0}C and Tmin. 22°C) or first week of November (mean Tmax. 29°C and Tmin. 19°C). Natural infection of such widely grown common wild plants helped in survival of the bacterium as well as for inoculum build up. The active inoculum from weed hosts during August-September could easily be transported to nearby fields by rain and irrigation water run-off. Wild plants thus appeared to play an important role in widespread occurrence of bacterial wilt of cultivated vegetable crops in West Bengal. These hosts can also harbour the menacing pathogen in off-season, and also served as collateral hosts of the pathogen.

Nature of the pathogen

Morphological and biochemical studies reveal that all the isolates were gram negative, straight rod to bent rod, motile having flagella, showed positive oxidase reaction, could not produce levan from sucrose, could not liquefy gelatin, could not hydrolyse starch, produced lipase, could not grow at 4°C temperature, showed negative arginine hydrolase activity, methyl red (MR) test was negative, Voges-Praskauer (vp) test was positive, i.e. produced acetyl methyl-carbinol, i.e. acetoin by utilizing glucose, produced hydrogen sulphide by dissimilation of cystine and methionine, could not produce indole from tryptophan, catalase reaction was positive, i.e. it could convert hydrogen peroxide into water and oxygen. Above mentioned results confirmed that wilt causing bacterium was *Ralstonia solanacearum* previously known as *Pseudomonas solanacearum* (Kelman, 1953; Kelman, 1954; Hayward, 1964). Isolates have collected from different geographical and environmental milieu, from crop plants and wild plants did not show any type of variation in respect of physico-biochemical traits of the very microorganism.

On pathogenicity test, isolates of *R. solanacearum* from brinjal, tomato, potato, marigold, jute, chilli (Table 3) and eight wild plants i.e. *Croton sparsiflorus, Cestrum diurnum, Solanum indicum, S. sisymbriifolium, Physalis minima, Amaranthus spinosus, A. viridis* and *Datura metel* were found to be pathogenic on tomato and brinjal (Table 4).

Table 3: Pathogenicity of isolates of *R. solanacearum* from crop plants on brinjal and tomato

Sources of isolates of *Ralsonia solanacearum*	Stem injection method		Root dip method	
	Disease reaction on		Disease reaction on	
	Brinjal	Tomato	Brinjal	Tomato
Brinjal	++	++	++	++
Tomato	++	++	++	++
Potato	++	++	++	++
Chilli	+	+	+	+
Marigold	+	+	+	+
Jute	+	+	+	+
Ginger	-	-	-	-
Elephant foot yam	-	-	-	-

+ + = Rapid wilting (i.e. wilting occurs within 9 - 11 DAI), + = Moderate wilting (i.e. wilting occurs within 12 – 15DAI), - = No wilting, DAI = Days after inoculation

Table 4: Pathogenicity of isolates of *R. solanacearum* from weed hosts on brinjal and tomato

Sources of isolates	Disease reaction on	
	Brinjal	Tomato
Amaranthus spinosus	++	++
A. viridis	+	+
Costus speciosus	-	-
Croton spersiflorus	++	++
Cestrum diurnum	+++	+++
Datura metel	+	+
Physalis minima	+	+
Solanum indicum	++	++
S. sisymbrifolium	+	+

+++ = Very rapid wilting (i.e. wilting occurs within 7 - 8 DAI), + + = Rapid wilting, + = Moderate wilting, - = No wilting

Table 5: Pathogenicity of isolates of *R. solanacearum* from ginger, elephant foot yam and *Costus speciosus*

Sources of isolates	Response of pathogenicity test		
	Ginger	Elephant foot yam	Costus
Ginger	++	++	++
Elephant foot yam	++	++	+
Costus speciosus	++	+	++

+ + = Rapid wilting, + = Moderate wilting

Highly virulent isolates like the isolate from *Cestrum diurnum* developed symptoms rapidly on brinjal and tomato. But the isolates of ginger, elephant foot yam and wild host *Costus speciosus* belonged to same group and were pathogenic on these three hosts only (Table 3, 4, 5).

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