Original Research Article

Roving Survey of Panama wilt Disease (*Fusarium oxysporum* f. sp. cubense) of Banana in Bihar

Abstract

A survey of Panama wilt of banana was conducted in different districts of Bihar viz., Muzaffarpur, Vaishali, Samastipur, Darbhanga, Katihar, Purnea, Bhagalpur, Kishanganj and Saharsa. This disease was present in all the districts with different levels of percent wilt index. In the Vaishali belt (Zone–I), the maximum percent wilt index was recorded in the Vaishali district (30-45%) in cv. Malbhog (AAB) having sucker planting material in the year 2019-20. In the Koshi belt (Zone-II), the percent wilt index (External symptom) was highest in Purnea district (34-42%) in cv. Robusta (AAA) followed by district Saharsa (28-40%) and Kishanganj (25-38%). The lowest percent wilt index was found in districts Bhagalpur (22-38%) and Katihar (24-38%) in the year 2019 20. Panama wilt of banana incited by *Fusarium oxysporum* f. sp. *cubense* TR4 was recorded in the Koshi belt (Zone-II) having cv. Grand naine (AAA) and cv. Robusta (AAA) in Bihar only. While in Vaishali belt (Zone-I) was free from the incidence of *Fusarium* wilt of banana incited by *Fusarium oxysporum* f. sp. *cubens*e TR4.

Keywords: *Fusarium oxysporum* f. sp. *cubense* **(**FOC), Panama wilt, Race, TR4, Bihar.

Introduction

Banana (*Musa paradisiacal* Linn.) is important perennial monocotyledonous fruit crop. Which was belongs to family Musaceae. It produced parthenocarpic fruit, hence it is seedless. The cultivated hybrids are generally triploid 2n=3x=33. The banana plant is a perennial herb which is tree like. It has 9 to 15 leaves that are up to 9 ft long and 2 ft wide. It is herb hence, not having woody stem and pseudostem of parent plant was die after every growing season. Reference???

In India, bananas are prevailing and accepted fruit crops among the people, which are liked both by poor and rich alike. It is accessible around the year dissimilar to the occasional chance of different other fruits. 87% of the total bananas cultivated in subtropical and tropical areas are used for household utilization just, while just 13% of the complete product is traded; the banana yield is a critical crop at international markets fascinating US Doller 4.7 Billion per year [1].

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Cultivated banana and plantain are large herbaceous plants within the genus *Musa*. and mostly propagated from the mutant found in the wild population. The major problem in achieving the high productivity of banana is its susceptibility to various fungal, bacterial, and viral diseases. This disease reduces the yield and degrades the marketability of banana fruits. Important diseases of banana are Panama wilt, bunchy top, bacterial wilt, Sigatoka and fruit rot. Among these, Panama wilt disease is considered to be very serious in banana-growing areas [2].

The most important and economically destructive disease is "Panama wilt", it is also called as *Fusarium* wilt incited by *Fusarium oxysporum* f. sp. *cubense*. The Panama wilt disease is most destructive due to the emergence of new pathogenic race i.e. Tropical race (TR4). Panama wilt disease incidence in the Dwarf Cavendish group (Grand naine) of bananas was known to occur in Bihar since 2015.

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Add study objectives

Material and Method

Intensive roving surveys were conducted in major banana growing belt of Bihar i.e. Vaishali belt (Zone-I) comprises Samistipur, Muzaffarpur, Vaishali and Darbhanga districts while in Koshi belt (Zone-II) included Katihar, Purnea, Bhagalpur, Kishananj and Saharsa districts. Add the date or period of the survey In each district, many banana orchards were surveyed, and collected wilt disease specimens, and calculated percent wilt index.

Percent wilt index (PWI, external symptoms)

Percent wilt index (PWI) in each plot was calculated as per International Musa Testing Programme (IMTP rating scale) under the rating in 1-5 scale (Table 1).

Table 1. International Musa Testing Programme (IMTP rating scale) under the rating in 1-5 scale

Category	Reaction
1	Healthy
2	Little chlorosis and wilting with no petiole buckling
3	Moderate chlorosis and splitting of leaf base and wilting with some petiole buckling
4	Severe chlorosis and wilting, petiole buckling and stunting of newly emerged leaf
5	Dead

$$\text{Percent Wilt index} = \frac{\text{Total sum of numerical rating}}{\text{Total number of plants observed} \times \text{maximum category in the score chart}} \times 100$$

Percent Vascular Wilt Index (PVWI, Internal symptom)

For determination of internal symptom of Panama wilt using the percent vascular wilt index (PVWI).Affected plant was cut transversally and longitudinal section determine the percent vascular wilt index (PVWI) as per IMTP rating in 1-6 scale (Table 2).

Table 2. IMTP rating in 1-6 scale

Rating	Symptom
1	Corm completely clean
2	Discoloration of isolated point
3	1/3 parts of vascular tissue discoloration
4	Between 1/3 to 2/3 parts of vascular tissue discolouration
5	Greater than 2/3 parts of vascular tissue discolouration
6	Completely discoloration of vascular tissue

$$\text{Percent vascular wilt index} = \frac{\text{Total sum of numerical rating}}{\text{Total number of plants observed} \times \text{maximum category in the score chart}} \times 100$$

Collection of disease sample

During the survey sample of the banana plant showing a typical external symptom of Panama wilt collected from the farmer's field. Each sample was placed in a paper towel and marked with the location and variety. The sample was brought at the Department of Plant Pathology, RPCAU, Pusa, laboratory, washed thoroughly in running tap water to remove soil particles and then kept in the refrigerator at 4°C for further study.

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Results and Discussion

Panama wilt of banana incited by *Fusarium oxysporum* f. sp. *cubense* is a devastating disease in Bihar, due to the presence of new pathogenic race i.e. Tropical Race 4 (TR4). An intensive roving survey was conducted in October, November, and December of 2019-20 in all the major banana growing districts of Bihar. All the banana districts are categorized into two belts i.e. Vaishali belt (Zone-I) and Koshi belt (Zone-II). In Vaishali belt (Zone-I) includes four

districts Samastipur, Muzaffarpur, Vaishali and Darbhanga. While in Koshi-belt (Zone-ll) include five districts Bhagalpur, Katihar, Purnea, Saharsa and Kishanganj. In the Vaishali belt, Panama wilt index percent was found highest in the Vaishali district in cv Malbhog(AAB) having sucker planting material (30-45%) followed by Muzaffarpur (25-42%), Samastipur (30-40%) and Darbhanga (28-38%) during 2019-20. Among the banana cultivars, highest percent Panama wilt index was observed in cv Malbhog (AAB) (30-45%) while lowest in cv Alpan (AAB) (12-18%). In the Dwarf Cavendish group of banana cultivars like Robusta (AAA) and Grand naine (AAA) were found free from Panama wilt disease during the survey.

In the Koshi belt, the highest percent wilt index (External symptom) was found in cv. Robusta (AAA) in Purnea district (34-42%) followed by Saharsa(28-40%), Kishanganj(25-38%), Bhagalpur (22-38%) and Katihar(24-38%). Panama wilt of banana incited by *Fusarium oxysporum* f. sp. *cubense* TR4 was recorded in the Koshi belt (Zone-II) of Bihar only. While zone-I was free from the incidence of *Fusarium* wilt of banana incited by *Fusarium oxysp*orum f. sp. *cubens*e TR4. Data are presented in (Table 3~~1~~&~~2~~4).

First time detects that the presence of *Fusarium* wilt of banana in Panama, Costa Rica, and Honduras [3].

The fungus *Fusarium oxysporum* f .sp. *cubense* was 1st time isolated in India from disease affected banana plant tissue in Bengal. Panama wilt resistance cultivars were Amritsagar, Kabuli, Agnishwar and Chinchamapa found [4].

Banana cultivars Chinnamondan plantains at Sholavandan and Arapalaiyam, Madras were affected with Panama wilt nearly 30% of the total plants were damaged. Later, Wollenweber found that the causal agent was as *Fusarium oxysporum* f. sp. *cubense* var Inodoratum [5].

Poona, the major spreading of *Fusarium* wilt attacking the locally grown Son variety [6]. Panama wilt was extensively investigated in the agro-ecological condition of Bihar [7].

Fusarium wilt of banana spread with in the country by infected planting material in the South African population. The availability of single planting material and narrow diversity of fungus showed it unlikely to reduce disease management principles include host resistance [8].

Recent presence of profoundly destructive type virulent race of fungus *Fusarium oxysporum* f. sp. *cubense* in Asia, recognized as tropical race 4 (TR4). It affected the Cavendish banana in Malaysia and Indonesia in year 1990s and in the Northern Territory of Australia it becomes epidemic in the year from 1997 to 1999. In the year 2004, serious infection in the banana crop was in Guangdong province, South China due to TR4 [9].

Fusarium oxysporum f. sp. *cubense* TR4, which affects banana crops in Asia, which is a major threat to the banana industry. In Latin America is almost hundred percent Cavendish subgroup of banana is susceptible to TR4 [10].

In 2013, race TR4 was found in Jordan, the 1st official report the presence of TR4 in the Southeast Asia-Pacific region. In 2014 survey conducted then found another infected area north of the original outbreak [11-12]. Reported that TR4 is a noteworthy issue for the Cavendish group of banana developing zones in Pakistan and detailed that cv. Basrai to be influenced by TR4 in specific zones in the Sindh territory and create devastation for the banana industry and devastating economically in Pakistan.

In 2018, tropical race 4 (TR4) as conforming in Myanmar. The samples were analyzed from the isolates Laos, Vietnam and Myanmar provided proof of particular TR4 strain in these countries as may be introduced from China [13].

detailed TR4 strain in lower Carmel coastal plain (1,200 ha), Jordan valley (800 ha) of Israel and western Galilee (500 ha) [14].

Survey of various districts Sri Lanka (Rajanganaya, Kandy, Kegalle, Rambukkana, Warakapola, Matale, Dambulla, Attanagalla, Ratnapura, Hamabanthota and Udawalawe) to differentiated banana developing regions infected by *Fusarium oxysporum* f. sp. *cubens*e [15].

Presence of *Fusarium oxysporum* f. sp. *cubense* TR4 in Barari village in Katihar district of Bihar. The incidence of Panama wilt disease ranged from 2 to 26.6% in Cavendish banana cvs. Robusta and Grand naine. There was a variation in percent wilt index from cultivar to cultivar in banana. Presently, based on the survey the presence of new pathogenic race TR4 has a serious threat to the banana industry in Bihar [16]. The first incidence of Panama wilt of banana in Bihar (Hazipur) was reported [17].

Singh (2002) described the prevalence of *Fusarium oxysporum* f. sp. *cubense* (FOC) race 1 & 2 in banana-growing areas of Vaishali and Samastipur districts of Bihar, India. Race 1 of FOC was already reported, while the existence of race 2 was reported probably for the first time.

Singh (2005) reported that Malbhog (AAB, silk) banana was becoming extinct in the Vaishali area of Bihar due to wilt. The traditional growers have discarded Malbhog in favour of other cultivars like Chinia and Alpan.

Singh (2003) first reported a breakage of resistance in Alpan (AAB, Mysore group) to FOC race 1 which was earlier considered resistant to wilt. Its incidence varied from 0-16 percent.

Fusarium oxysporum f. sp. *cubense* (FOC) present in Uttar Pradesh in September 2017 [18].

Districts	Variety	Genomic group	No. of orchards surveyed	Planting material	External symptoms (PWI 1-5 IMTP rating scale)

Surveyed Panama wilt affected areas in Bihar during 2016-17 to 2018-19. The highest percent wilt index was recorded in cv. Malbhog (AAB) from 36-40% to 30- 34% during 2016-17 to 2018-19 while, in Samastipur districts and lowest percent wilt index was found in cv. Alpan (AAB) from 21-23% to 16-17% during 2016- 17 to 2018-19 in the Darbhanga district of Vaishali belt (Zone-I). In the Koshi belt (Zone-II), the highest percent wilt index was recorded in cv. Grand naine (AAA) from 23-25% to 28-34% during 2016-17 to 2018-19 of Bhagalpur district and lowest percent wilt index was found in cv. Basrai (AAA) from 9-11% to 14-18% during 2016-17 to 2018-19 of Kishanganj district [19].

Plate-1. Panama wilt infected banana orchards at Dhamdaha village in Purnia district of Bihar

Table -~~1~~3. Scenario of Panama wilt of banana in Vaishali belt (Zone I) of Bihar during 2019-20 complete the table

Samastipur	Malbhog	(AAB)	26	Sucker	30-40
	Alpan	(AAB)		Sucker	18-25
	Champa	(AAB)		Sucker	20-35
	Kothia	(ABB)		Sucker	25-30
	Robusta	(AAA)		Sucker	0
	Grand naine	(AAA)		Tissue Culture	0
Muzaffarpur	Malbhog	(AAB)	28	Sucker	25-42
	Alpan	(AAB)		Sucker	26-30
	Kanthali	(AAB)		Sucker	25-34
	Champa	(AAB)		Sucker	20-28
	Robusta	(AAA)		Sucker	0
	Kothia	(ABB)		Sucker	22-34
	Chinia	(AAB)		Sucker	22-25
	Grand naine	(AAA)		Tissue Culture	0
Vaishali	Chinia	(AAB)	24	Sucker	25-38
	Malbhog	(AAB)		Sucker	30-45
	Alpan	(AAB)		Sucker	14-18
	Grand naine	(AAA)		Tissue Culture	0
	Chini Champa	(AAB)		Sucker	20-24
	Kothia	(ABB)		Sucker	14-20
Darbhanga	Chinia	(AAB)	22	Sucker	22-30
	Malbhog	(AAB)		Sucker	28-38
	Robusta	(AAA)		Sucker	0
	Alpan	(AAB)		Sucker	12-18
	Grand naine	(AAA)		Tissue Culture	0

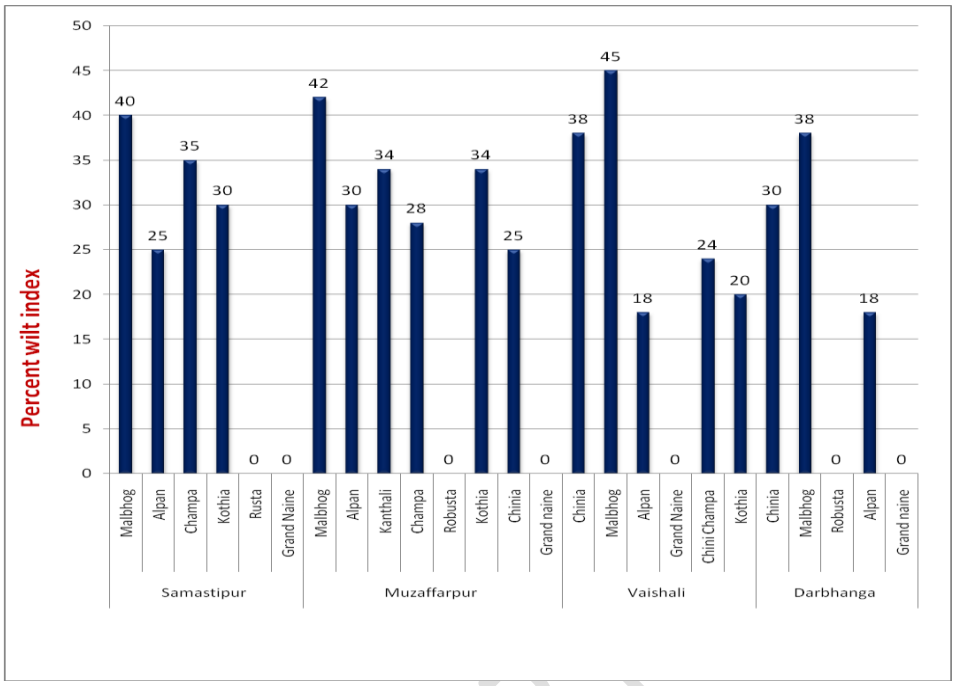

Fig. 1. Scenario of Panama wilt of banana in Vaishali belt (Zone I) of Bihar during 2019-2020.

Table -~~24~~. Scenario of Panama wilt of banana in Koshi belt (Zone- II) of Bihar during 2019-2020

Districts	Variety	Genomic group	No. of orchards surveyed	Planting material	External symptoms (PWI 1-5 IMTP rating scale)
Katihar	Robusta	(AAA)	25	Sucker	24-38
	Grand naine	(AAA)		Tissue culture	26-35
Purnea	Grand naine	(AAA)	30	Tissue culture	24-38
	Robusta	(AAA)		Sucker	34-42
Bhagalpur	Grand naine	(AAA)	28	Tissue culture	22-38
	Robusta	(AAA)		Sucker	26-36
Saharsa	Robusta	(AAA)	26	Sucker	26-38
	Grand naine	(AAA)		Tissue culture	28-40
Kishanganj	Robusta	(AAA)	15	Sucker	25-38
	Grand naine	(AAA)		Tissue culture	28-36

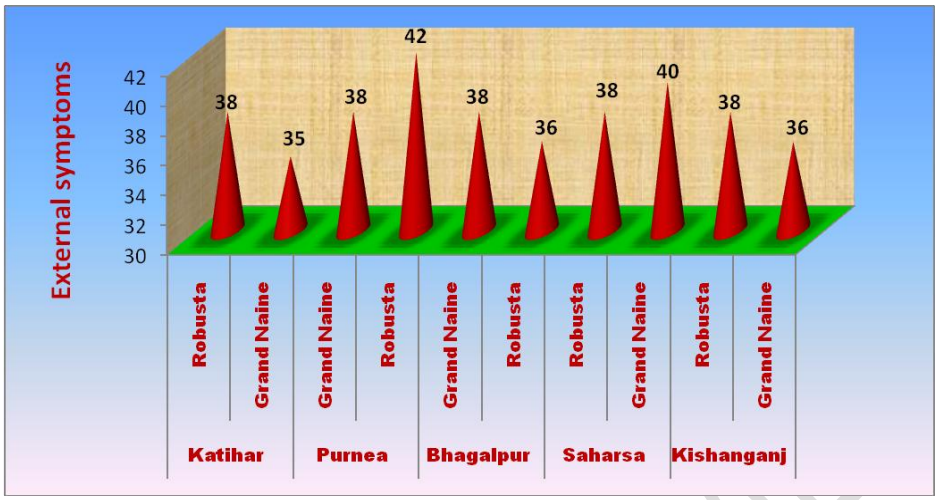

Fig.2.Scenario of Panama wilt of banana in Koshi belt (Zone II) of Bihar during 2019-20.

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