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Status of papaya viral disease incidence during *Kharif, Rabi* and summer seasons in Begusarai district of north Bihar

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Abstract

Papaya is the most important fruit crop grown in Begusarai district of Bihar. Susceptibility of papaya to a number of viral diseases like mosaic, leaf curl and ring spot is the limiting factor for its economic production. A systematic survey was conducted during 2013-15 to assess the effect of sowing season in nursery and planting season in the main field on natural incidence of papaya viral diseases spread in five blocks of Begusarai district in north Bihar. During survey nursery sown for kharif, rabi and summer transplantation were free from the incidence of leaf curl and ring spot virus diseases but they had the incidence of mosaic in the range of 2.24 to 8.0% (Seed sown in June) for kharif transplantation, 1.24 to 6.30% (seed sown in October) for rabi transplantation and in the range of 0.20 to 1.40% (seed sown in March) for summer transplantation. The incidence of mosaic in the range of 24.70 to 42.20%, leaf curl of 2.15 to 4.75% and ring spot virus disease range of 22.50 to 36.40% were recorded from plants transplanted in kharif season whereas incidence of mosaic in the range of 18.60 to 33.20%, leaf curl of 1.20 to 3.50% and ring spot 17.25 to 30.75% were counted on plants transplanted in rabi season. The incidence of mosaic in the range of 8.25 to 20.40%, leaf curl of 0.00 to 1.25% and ring spot of 7.70 to 18.70% were recorded from plants transplanted in summer season. The total viral diseases in the range of 49.37 to 83.35%, 37.70 to 66.25% and 15.95 to 40.35% were recorded respectively from kharif, *Rabi* and summer transplanted papaya fields.

Keywords: Papaya, insecticides, mosaic, leaf curl, ring spot virus.

Introduction

Papaya is one of the major fruit crop of India. The national production of papaya is 53.82 lakh tonnes and contributes about 30% of total world production from an area of 1.32 lakh hectares with an average yield of 40.7 tones / ha (NHB, 2013) ^[4]. It is mainly cultivated in Andhra Pradesh, Gujrat, Maharashtra, West Bengal, Karnataka and Chhattisgarh and these states cover more than 75% total area and contribute about 85% of countries total papaya production (Shyamal *et al.*, 2010) ^[8]. Papaya occupies an important position among fruit crops in Bihar with a production of 50.2 thousand tonnes from 2.1 thousand hectares. Over the last two decades this crop has experienced considerable reduction in yield due to attack of various diseases. The crop infected by 12 viral, 8 bacterial, 33 fungal, 6 nematodal and 2 phytoplasmal diseases (Nishijima, 1999) ^[5] of which viral diseases gained global importance in all the papaya growing countries. In India viral diseases such as mosaic, leaf curl and ring spot prevail in all the states wherever papaya is cultivated. Susceptibility of papaya to a number of viral diseases is the limiting factor for its economic production throughout the tropics and subtropics (Verma, 1996) ^[9]. Diseases like papaya mosaic, leaf curl and ring spot virus are of the major concern for reducing the papaya production and productivity in the subtropical climate Bihar. Hence the efforts have been made to assess the incidence of the viral diseases in three seasons such as kharif, rabi and summer both in nurseries and main fields of papaya spread in five blocks of Begusarai district of north Bihar. The present paper particularly deals with the survey about the effect of sowing season in nursery and planting season in main field on natural incidence of viral diseases like mosaic, leaf curl and ring spot in papaya.

Materials and Methods

Survey for incidence of papaya viral diseases was conducted during 2013-15 in three seasons such as in kharif, rabi and summer at various stages of plant growth that is in nursery (seed

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sown in June, October and March) and in main field (seedlings transplanted in July, November and April). The natural incidence of viral diseases was recorded separately for each of the season in nursery after 50 days of sowing where as in the main after 10 months of transplantation. The survey was conducted for kharif, rabi and summer season in 125 fields spread over five blocks viz. Begusarai, Barauni, Bachhwara, Bhagwanpur and Bakhri. Five villages in each block, five fields in each village and 200 plants in each field (nursery & main field), were randomly selected in all the three seasons during the course of survey. The area of the main field plantation ranged between 0.25 and 0.5 ha whereas the area of nurseries ranged between 20-40 sq m. The nurseries and papaya planted in the main fields selected for studies were managed with almost similar practices. The plants were maintained with inputs and cultural practices by the farmers themselves and flood irrigation method was being followed to irrigate the plantation at all the locations. The selected nurseries and papaya transplanted main fields in selected villages and blocks inspected for two consecutive years 2013-14 & 2014-15. The disease incidence was recorded by counting the total number of plants and the number of plants showing mosaic, leaf curl and ring spot viral disease symptoms in selected nurseries as well as in the main fields. The percent disease incidence was calculated by using the formula.

$$\text{Percent Disease Incidence (PDI)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Results and Discussions

The data in table 1 indicate that nursery plants were free from the incidence of leaf curl and ring spot virus diseases but had the highest incidence of mosaic (8.0%) in Suryapura village (Bhagwanpur block), and followed by mosaic incidence of 7.50% in the Mohanpur village (Begusarai block) though minimum incidence of 2.24% was recorded from the nursery fields of Bagwan village (Bakhari block). The incidence of all the three viral diseases were observed in all the main fields during the kharif season. The leaf curl incidence in the range of 2.15 to 4.75%, mosaic incidence is the range of 24.70 to 42.20% and ring spot incidence in the range of 22.50 to 36.40% were recorded on papaya plants in the main fields during kharif season. The maximum mosaic incidence (42.20%), maximum leaf curl incidence (4.75%) and maximum ring spot virus incidence (36.40%), were observed in the main fields of Suryapura village of Bhagwanpur block where as minimum mosaic incidence (24.70%), minimum leaf curl incidence (2.15%) and minimum ring spot virus incidence (22.50%) were recorded from the fields of Bagwan village (Bakhari block). The highest (83.35%) and lowest (49.35%) incidences of total viral diseases were respectively recorded from the main fields of Suryapura village (Bhagwanpur block) and Bagwan village (Bakhari block). This is also evident from Table 2 that papaya plants in all the nurseries of all the five blocks were found free from the incidence of leaf curl and ring spot virus diseases but they had the incidence of mosaic in the range of 1.24 to 6.30%. In case of one year old plants in the main fields all the three virus diseases such as mosaic, leaf curl and ring spot were observed. None of the main field was found free from the incidences of these three viral diseases. The maximum incidence of mosaic (33.20%) and ring spot (30.75%) were recorded from the fields of Ulaio village of Begusarai block

though the maximum incidence of leaf curl (3.50%) was also noticed under Begusarai block but from the main fields of Khamhar village. The minimum incidence of mosaic (18.60%), leaf curl (1.20%) and ring spot (17.25%) were observed respectively from the main fields of Madaipura village (Bhagwanpur block), Makardahi village (Brauni Block) and Murlitol village (Bachhwara block). The highest (66.25%) and lowest (39.20%) incidence of total virus diseases were recorded respectively from the main fields of Ulaio and Mohanpur village of Begusarai block.

This is also clearly indicated from Table-3 that papaya plants in nurseries were free from the incidences of leaf curl and ring spot virus diseases but they had the highest incidence of mosaic (1.40%) in the Killi village (Begusarai block) and followed by the mosaic incidence of 1.30% in the Tulsipur village (Bakhri block) though minimum incidence of 0.20% was recorded in Suryapura village (Bhagwanpur block). None of the nursery was exempted from mosaic incidence during the course of survey. The incidence of all the three viral diseases were noticed in all the main fields of one-year plantation. The mosaic incidence was recorded more than leaf curl and ring spot virus diseases in almost all the main fields. The leaf curl incidence was recorded in the range of 0.10 to 1.25% except three sites Nonpur village (Barauni block), Murlitol village (Bachhwara block) and Suryapura village (Bhagwanpur block), where papaya plants were exempted from incidence of leaf curl disease. The mosaic incidence of 8.25% to 20.40% and papaya ring spot virus incidence of 7.70 to 18.70% were recorded from main fields from summer plantation. The maximum mosaic incidence (20.40%) and maximum ring spot virus disease (18.70%) were observed from the fields of Killi village of Begusarai Block. The minimum mosaic incidence (8.25%) and minimum ring spot virus disease (7.70%) were respectively recorded from the fields of Murlitol village (Bachhwara block). The highest (40.35%) and lowest (15.95%) incidences of total virus diseases were respectively recorded from the fields of Killi village (Begusarai block) and Murlitol village (Bachhwara block).

The data in Table 4 indicate that the nursery plants in all the fields of all the five blocks were free from the incidence of leaf curl and papaya ring spot virus diseases in all the three seasons kharif, rabi and summer but they were with the average mosaic percent incidence in the range of 4.05% to 5.64% in kharif season, 2.51% to 3.72% in rabi season and 0.61% to 0.91% in summer season. During the course of survey of main fields in kharif season Bhagwanpur block recorded highest average percentage of total viral disease incidence (73.12%) followed by Begusarai block (68.19%), Bachhwara block (67.47%), Bakhari block (65.78%) and Barauni block (65.48%) respectively. In rabi season the maximum average percentage of total viral disease incidence (54.17%), was recorded from Bakhari block followed by Begusarai (51.85%), Bachhwara (51.54%), Barauni (49.92%) and Bhagwanpur block (45.62%) respectively but in summer season Begusarai block recorded highest average percentage of total viral disease incidence (29.25%) followed by Bakhari (27.27%), Barauni (25.42%), Bachhwara (25.04%) and Bhagwanpur block (23.24%) respectively. The average percent mosaic incidence ranged from 32.45 to 35.33%, average percent leaf curl disease incidence ranged from 3.11 to 3.88% and average percent ring spot disease incidence ranged from 30.08 to 33.91% were recorded from main fields during kharif whereas average percent mosaic disease incidence ranged from 23.06 to 26.52%, average percent leaf

curl disease incidence ranged from 1.72 to 2.11% and average percent ring spot disease incidence ranged from 20.33 to 25.80% were recorded from main fields of rabi season. The average percent mosaic disease incidence ranged from 12.58 to 15.29%, average percent leaf curl disease incidence ranged from 0.33% to 0.76% and average percent ring spot disease incidence ranged from 10.29 to 13.18% were recorded during the course of survey in summer season.

The mean of average incidence of total viral disease and mean of average mosaic incidence in nursery (4.58%) sown for kharif season and mean of average incidence of total viral disease and mean of average mosaic incidence in nursery (2.97%) sown for rabi season was found more compared to mean of average incidence of total viral disease and mean of average mosaic incidence in nursery (0.75%) sown for summer plantation. Similarly the mean of average incidence of total viral disease (68%), mean of average mosaic incidence (33.28%), mean of average leaf curl incidence (3.43%) and mean of average ring spot virus disease (31.45%) in the main fields of kharif season and mean of average incidence of total viral disease (50.61%), mean of average mosaic incidence (25.55%), mean of average leaf curl incidence (1.93%) in main fields of rabi season were found more compared to mean of average incidence of total viral disease (26.03%), mean of average ring spot virus disease incidence (11.63%), mean of average mosaic disease incidence (11.63%) and mean of average leaf curl disease incidence (0.44%) in main fields of summer season. The incidence of mosaic in nursery sown for plantation in all the three seasons and the incidences of mosaic and ring spot virus disease in main fields were recorded as prevalent diseases in all the fields of papaya under all the five blocks of surveyed area in kharif, rabi as well as in summer season. Roy *et al.* (2000)^[7] assessed the incidence of viral diseases in nursery and field plantation of papaya under north Bihar agro climate

and reported that plants in the nurseries were free from leaf curl and papaya ring spot virus but they had incidence of mosaic in the range of 2.1 to 5.1%. He also reported that all the three viral diseases were observed in one year old plantation. The incidence of mosaic was observed more than papaya ring spot virus. The leaf curl incidence was noticed in 1.2-4.8% plants. A total of 16.2 to 30.4% plants suffered from viral disease when plants were one year old. He also observed that the presence of only 2.1 to 5.1% of infected plants at seedling stage resulted in over 70% of plants becoming infected by the second year.

The total viral disease incidence ranging from 49.37 to 83.35% in the main fields of kharif season and total viral incidence ranging from 37.70% to 66.25 % in the main fields of rabi season created more economic losses to the papaya growers in comparison to summer plantation where total viral disease incidence ranged only from 15.95 to 40.35%. The observation is in accordance with Ram and Singh (1999)^[6] who observed that transplanting the papaya seedling in summer season (February-March) showed longer PRSV free period than kharif and rabi seasons. With viruses that have an airborne vectors, the choice of planting may influence the time and amount of infection. The best planting season will depend on the time of migration of the vectors. Summer planting may enable the papaya to avoid virus vectors and also plants may show increase resistance as they grow old. The effect of infection on yield is usually much higher when young plants are infected. For any particular crop, the effectivity of changed planting in minimizing virus infection has to be considered in relation to the economic factors (Broadbent *et al.* 1952, Cadman and Chambers, 1960)^[1, 2]. Mora-Aguilera *et al.* (1996)^[3] reported the usefulness of transplanting times in controlling papaya ring spot virus in central Veracruz, Mexico.

Table 1: Incidence of papaya viral disease during *kharif* season (2013-15) in Begusarai district of north Bihar.

Places	Disease Incidence (%)							
	Nursery plant				One year old plant			
	Mosaic	Leaf curl	Ring Spot	Total	Mosaic	Leaf curl	Ring Spot	Total
Begusarai Block								
Killi	3.80	0.00	0.00	3.80	34.10	3.20	30.40	67.70
Paharpur	3.10	0.00	0.00	3.10	30.40	3.00	28.20	61.60
Khamhar	4.60	0.00	0.00	4.60	33.70	3.90	32.25	69.85
Ula	3.42	0.00	0.00	3.42	29.20	2.70	28.20	61.10
Mohanpur	7.50	0.00	0.00	7.50	40.25	4.25	36.20	80.70
Barauni Block								
Keshave	3.40	0.00	0.00	3.40	28.20	2.40	24.10	54.70
Babangama	4.10	0.00	0.00	4.10	26.80	2.70	32.40	61.90
Makardahi	3.75	0.00	0.00	3.75	35.20	3.25	30.20	68.65
Nonepur	6.00	0.00	0.00	6.00	38.25	3.65	34.10	76.00
Malti	4.70	0.00	0.00	4.70	35.10	3.55	32.50	71.15
Bachhwara Block								
Narepur	5.75	0.00	0.00	5.75	39.80	4.10	35.20	76.50
Bachhwara	3.40	0.00	0.00	3.40	30.00	2.90	28.40	61.30
Maranchi	3.80	0.00	0.00	3.80	26.20	3.40	30.90	60.50
Rani	4.50	0.00	0.00	4.50	33.40	3.65	31.75	68.80
Murlitol	4.30	0.00	0.00	4.30	32.85	3.20	31.20	67.25

Cont.

Places	Disease Incidence (%)							
	Nursery plant				One year old plant			
	Mosaic	Leaf curl	Ring Spot	Total	Mosaic	Leaf curl	Ring Spot	Total
Bhagwanpur Block								
Bhagwanpur	4.35	0.00	0.00	4.35	30.80	3.50	32.00	66.30
Suryapura	8.00	0.00	0.00	8.00	42.20	4.75	36.40	83.35

Chandaur	5.40	0.00	0.00	5.40	37.20	4.10	34.60	75.90
Madhaipura	4.85	0.00	0.00	4.85	31.80	3.70	32.80	68.80
Pasopur	5.60	0.00	0.00	5.60	34.65	3.35	33.75	71.75
Bakhri Block		0.00	0.00					
Gangrahaio	4.50	0.00	0.00	4.50	33.70	3.10	31.20	68.00
Bagwan	2.24	0.00	0.00	2.24	24.70	2.15	22.50	49.35
Tulsipur	5.60	0.00	0.00	5.60	39.10	4.20	35.10	78.40
Simri	4.70	0.00	0.00	4.70	33.75	3.70	32.40	69.85
Koelamohan	3.25	0.00	0.00	3.25	30.70	3.40	29.20	63.30

Table 2: Incidence of papaya viral disease during *Rabi* season (2013-15) Begusarai district of north Bihar

Places	Disease Incidence (%)							
	Nursery plant				One year old plant			
	Mosaic	Leaf curl	Ring Spot	Total	Mosaic	Leaf curl	Ring Spot	Total
Begusarai Block								
Killi	2.80	0.00	0.00	2.80	24.30	1.40	20.50	46.20
Paharpur	3.60	0.00	0.00	3.60	26.40	1.75	22.75	50.90
Khamhar	3.75	0.00	0.00	3.75	29.50	3.50	24.20	57.20
Ulaio	6.30	0.00	0.00	6.30	33.20	2.30	30.75	66.25
Mohanpur	2.10	0.00	0.00	2.10	19.20	1.60	18.40	39.20
Barauni Block								
Keshave	2.60	0.00	0.00	2.60	25.20	1.75	21.30	48.25
Babangama	3.40	0.00	0.00	3.40	25.66	1.80	22.25	49.71
Makardahi	1.75	0.00	0.00	1.75	20.40	1.20	18.75	40.35
Nonepur	2.10	0.00	0.00	2.10	22.75	1.25	22.80	46.80
Malti	4.00	0.00	0.00	4.00	32.50	2.60	29.40	64.50
Bachhwara Block								
Narepur	4.00	0.00	0.00	4.00	29.70	2.20	27.80	59.70
Bachhwara	2.80	0.00	0.00	2.80	27.25	2.60	24.75	59.70
Maranchi	2.66	0.00	0.00	2.66	26.30	1.66	22.60	50.56
Rani	2.50	0.00	0.00	2.50	25.25	1.80	24.75	51.80
Murlitol	2.30	0.00	0.00	2.30	21.80	1.50	17.25	40.55

Cont.

Places	Disease Incidence (%)							
	Nursery plant				One year old plant			
	Mosaic	Leaf curl	Ring Spot	Total	Mosaic	Leaf curl	Ring Spot	Total
Bhagwanpur Block								
Bhagwanpur	2.20	0.00	0.00	2.20	23.66	1.90	20.70	46.26
Suryapura	3.25	0.00	0.00	3.25	24.30	2.10	21.80	48.20
Chandaur	1.50	0.00	0.00	1.50	22.75	1.75	19.40	43.90
Madhaipura	1.24	0.00	0.00	1.24	18.60	1.60	17.50	37.70
Pasopur	4.66	0.00	0.00	4.66	27.00	2.80	22.25	52.05
Bakhri Block								
Gangrahaio	2.50	0.00	0.00	2.50	26.80	1.80	26.75	55.35
Bagwan	1.50	0.00	0.00	1.50	22.40	1.30	22.00	45.70
Tulsipur	3.66	0.00	0.00	3.66	28.20	2.20	27.80	58.20
Simri	5.75	0.00	0.00	5.75	30.75	2.40	28.75	61.65
Koelamohan	1.66	0.00	0.00	1.66	24.75	1.50	23.70	49.90

Table 3: Incidence of papaya viral disease during summer season (2013-15) in Begusarai district of north Bihar

Places	Disease Incidence (%)							
	Nursery plant				One year old plant			
	Mosaic	Leaf curl	Ring Spot	Total	Mosaic	Leaf curl	Ring Spot	Total
Begusarai Block								
Killi	1.40	0.00	0.00	1.40	20.40	1.25	18.70	40.35
Paharpur	0.75	0.00	0.00	0.75	13.30	0.60	11.20	25.10
Khamhar	1.10	0.00	0.00	1.10	15.75	0.80	13.60	30.15
Ulaio	0.80	0.00	0.00	0.80	13.80	0.75	12.00	26.55
Mohanpur	0.50	0.00	0.00	0.50	13.20	0.40	10.40	24.00
Barauni Block								
Keshave	1.10	0.00	0.00	1.10	16.50	0.75	14.50	31.75
Babangama	0.40	0.00	0.00	0.40	12.40	0.20	10.75	23.35
Makardahi	1.10	0.00	0.00	1.10	14.20	0.40	12.60	27.20
Nonepur	0.30	0.00	0.00	0.30	10.75	0.00	8.40	18.65
Malti	0.50	0.00	0.00	0.50	13.75	0.30	12.10	26.15
Bachhwara Block								

Narepur	0.80	0.00	0.00	0.80	18.10	0.60	11.75	30.45
Bachhwara	0.75	0.00	0.00	0.75	11.40	0.20	11.40	23.00
Maranchi	0.40	0.00	0.00	0.40	10.60	0.20	8.90	19.70
Rani	1.25	0.00	0.00	1.25	19.30	0.70	16.10	36.10
Murlitol	0.30	0.00	0.00	0.30	8.25	0.00	7.70	15.95

Cont.

Places	Disease Incidence (%)							
	Nursery plant				One year old plant			
	Mosaic	Leaf curl	Ring Spot	Total	Mosaic	Leaf curl	Ring Spot	Total
Bhagwanpur Block								
Bhagwanpur	0.40	0.00	0.00	0.40	9.30	0.20	8.20	17.70
Suryapura	0.20	0.00	0.00	0.20	8.60	0.00	7.80	16.40
Chandaur	0.50	0.00	0.00	0.50	12.10	0.30	9.10	21.50
Madhaipura	0.75	0.00	0.00	0.75	16.10	0.60	12.10	28.80
Pasopur	1.20	0.00	0.00	1.20	16.80	0.75	14.25	31.80
Bakhri Block								
Gangrahaio	1.00	0.00	0.00	1.00	15.40	0.60	12.25	28.25
Bagwan	0.70	0.00	0.00	0.70	12.75	0.25	9.80	22.80
Tulsipur	1.30	0.00	0.00	1.30	19.70	0.70	16.40	36.80
Simri	0.60	0.00	0.00	0.60	12.30	0.10	8.70	26.10
Koelamohan	0.80	0.00	0.00	0.80	14.80	0.50	12.10	27.40

Table 4: Average incidence of papaya viral diseases at block level in Begusarai district during *Kharif*, *Rabi* and summer seasons

Name of Block	Season	Disease Incidence (%)							
		Nursery plant				One year old plant			
		Mosaic	Leaf curl	Ring Spot	Total	Mosaic	Leaf curl	Ring Spot	Total
Begusarai	<i>Kharif</i>	4.48	0.00	0.00	4.48	33.53	3.41	31.05	68.19
Barauni	<i>Kharif</i>	4.39	0.00	0.00	4.39	32.71	3.11	30.66	65.48
Bachhwara	<i>Kharif</i>	4.35	0.00	0.00	4.35	32.45	3.45	31.57	67.47
Bhagwanpur	<i>Kharif</i>	5.64	0.00	0.00	5.64	35.33	3.88	33.91	73.12
Bakhri	<i>Kharif</i>	4.05	0.00	0.00	4.05	32.39	3.31	30.08	65.78
Mean		4.58	0.00	0.00	4.58	33.28	3.43	31.45	68.00
Begusarai	<i>Rabi</i>	3.72	0.00	0.00	3.72	26.52	2.11	23.22	51.85
Barauni	<i>Rabi</i>	2.77	0.00	0.00	2.77	25.30	1.72	22.90	49.92
Bachhwara	<i>Rabi</i>	2.85	0.00	0.00	2.85	26.16	1.95	23.43	51.54
Bhagwanpur	<i>Rabi</i>	2.51	0.00	0.00	2.51	23.26	2.03	20.33	45.62
Bakhri	<i>Rabi</i>	3.01	0.00	0.00	3.01	26.53	1.84	25.80	54.17
Mean		2.97	0.00	0.00	2.97	25.55	1.93	23.13	50.61
Begusarai	Summer	0.91	0.00	0.00	0.91	15.29	0.76	13.18	29.23
Barauni	Summer	0.68	0.00	0.00	0.68	13.42	0.33	11.67	25.42
Bachhwara	Summer	0.70	0.00	0.00	0.70	13.53	0.34	11.17	25.04
Bhagwanpur	Summer	0.61	0.00	0.00	0.61	12.58	0.37	10.29	23.24
Bakhri	Summer	0.88	0.00	0.00	0.88	14.99	0.43	11.85	27.27
Mean		0.75	0.00	0.00	0.75	13.96	0.44	11.93	26.03

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