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Research Article

Incidence and severity of fungal rot of tomato and brinjal in Kashmir Valley

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Abstract

The incidence of fungal rot diseases of tomato and brinjal showed significant variation in different areas/localities of Srinagar, Pulwama, Anantnag and Kulgam of Kashmir surveyed during study. Incidence and severity of fungal rot of tomato and brinjal caused by several pathogenic fungi was from lowest to highest in all the surveyed districts of Kashmir Valley. Among the isolated fungi *Aspergillus niger, Mucor plumbeus, Alternaria alternata* and *Penicillium expansum* were found most commonly responsible for fungal rot of tomato and brinjal. The incidence and severity showed considerable increase during the period of study in Srinagar, Pulwama, Anantnag and Kulgam districts of Kashmir Valley and thus warrants effective management strategies. Such types of study have been carried out for the first time in the valley.

Keywords: Incidence, severity, fungal pathogens, study sites.

1. INTRODUCTION

Tomato and brinjal (*Solanum melongena* L.) are considered important vegetables throughout the world. Tomato (*Lycopersicon esculentum* Mill.) belongs to family Solanaceae and is widely grown vegetable in the world. The leading producer of tomato in the world is USA followed by China, Italy, Turkey, Egypt, Spain, Romania, Brazil and Greece. In Kashmir Valley (India), the crop is grown over an area of 1200 hectares with an average yield of 250-300 quintal per hectare[1]. Tomato and brinjal were attacked by fungal diseases caused by pathogenic fungi resulting in huge losses to its production [2,3]. Postharvest decay of fruits and vegetables can be attributed to infections that occur either between flowering and fruit maturity or during harvesting and subsequent handling and storage[4]. Thus, the present study was undertaken to evaluate the incidence and severity of fungal rot of tomato and brinjal in some districts of Kashmir Valley.

2. MATERIALS AND METHODS

Incidence and severity of fungal rot of tomato and brinjal in Kashmir Valley.

For incidence and severity of fungal rot of vegetables such as tomato and brinjal in Kashmir, the regular survey of main vegetable growing belts of district Srinagar, Pulwama, Anantnag and Kulgam were conducted during three different growing seasons from 2013 to 2015, Nine areas/localities were selected from each district and from each locality infected and healthy vegetables were separately collected from vegetable fields, godowns, vegetable markets and storage houses in polythene bags, properly labeled and brought to laboratory for further observations. Incidence of rot on these vegetables was recorded as percent incidence of diseased vegetables after every collection. Diseased vegetables were grouped according to the visual observations and put in separate polythene bags for identifying the pathogen in the laboratory.

The percent disease incidence (PDI) was recorded by counting the number of vegetables showing rotting symptoms and worked out by the formula as given by[5].

$$\text{PDI} = \frac{\text{Number of rotten vegetables}}{\text{Total number of vegetables examined}} \times 100$$

Rot severity was recorded as per the grade scale and formula adopted by[6,7]

$$\text{Rot severity (\%)} = \frac{\text{Sum of all numerical rotting}}{\text{No of vegetables examined} \times \text{maximum grade value}} \times 100$$

Grade	Extent of rotting	Numerical score (%)
0	No rotting	0
1	Pin head to 10nm	10
2	Upto ¼ th of the fruit	25
3	Upto ½ of fruit	50
4	Upto ¾ th of the fruit	75
5	More than ¾ th of fruit	100

3. RESULTS

3.1. Incidence and severity of fungal rot of tomato

The incidence and severity of fungal rot of tomato was observed in some selected areas/localities of district Srinagar, Pulwama, Anantnag and Kulgam of Kashmir valley. The samples of vegetable such as tomato were collected from godowns, storage houses and local vegetable markets of the main towns of these districts and assessed for incidence and severity of fungal rots caused by different species of fungi. The detailed assessment of incidence and severity of fungal rot of tomato is determined as under:

3.1.1. Incidence and severity of fungal rot of tomato in some districts of Kashmir Valley.

The present study revealed that on tomato four fungal rot disease such as *Penicillium* rot of tomato caused by *Penicillium expansum*, *Aspergillus* rot of tomato caused by *Aspergillus niger*, *Alternaria* rot of tomato caused by *Alternaria alternata* and *Mucor* rot of tomato caused by *Mucor plumbeus* were prevalent in district Srinagar, Pulwama, Anantnag and Kulgam respectively (Table 1, Fig 1). The incidence and severity of fungal rot of tomato is described separately as under:

a. Incidence and severity of *Penicillium* rot of tomato caused by *Penicillium expansum* in some districts of Kashmir Valley.

It was revealed from the study (Table 1, Fig 1) that *Penicillium* rot of tomato caused by *Penicillium expansum* on tomato was prevalent in all the four districts surveyed. However, variation was found in the incidence and severity of *Penicillium* rot of tomato in all the four districts during the period of study. The highest incidence was found in district Srinagar followed by Pulwama, Kulgam and Anantnag respectively. Incidence of *Penicillium* rot of tomato in Srinagar ranged from 25.78% in 2013 to 29.60% in 2015. Similarly, incidence of *Penicillum* rot of tomato ranged from 24.42% in 2013 to 29.68% in 2015 in district Pulwama, whereas the incidence of *Penicillium* rot of tomato ranged from 23.40 % in 2013 to 29.61% in 2015 in Anantnag respectively. The incidence of *Penicillium* rot of tomato ranged from 24.31% in 2013 to 26.33% in 2015 in district Kulgam.

The severity of *Penicillium* rot of tomato also increased from 2013 to 2015, with the highest severity observed in district Pulwama followed by Anantnag, Kulgam and Srinagar (Table 1, Fig 2). In Srinagar, the rot severity ranged from 8.22% in 2013 to 11.39% in 2015. Likewise, in Pulwama, the rot severity ranged from 18.38% in 2013 to 17.04% in 2015, the severity of fungal rot ranged from 13.20% in 2013 to 16.55% in 2015 whereas in Kulgam, the rot severity ranged from 12.11% to 15.87% in 2015 respectively.

b. Incidence and severity of *Aspergillus* rot of tomato caused by *Aspergillus niger* in some districts of Kashmir Valley.

It was observed from the present study (Table 1, Fig 1) that *Aspergillus* rot of tomato caused by *Aspergillus niger* on tomato was observed in all the areas/localities of districts Srinagar, Pulwama, Anantnag and Kulgam respectively. However, there was found variation in the incidence and severity of *Aspergillus* rot of tomato in all the four districts during the period of study. The highest incidence was observed in district Pulwama followed by Srinagar, Anantnag and Kulgam respectively. Incidence of *Aspergillus* rot of tomato in Srinagar ranged from 28.42% in 2013 to 27.92% in 2015. Similarly, incidence of *Aspergillus* rot of tomato ranged from 28.85% in 2013 to 27.94% in 2015 in district Pulwama, whereas the incidence of *Aspergillus* rot of tomato ranged from 25.35% in 2013 to 23.62% in 2015 in Anantnag respectively. In district Kulgam, the incidence of *Aspergillus* rot of tomato ranged from 24.72% in 2013 to 20.41% in 2015 respectively.

The severity of *Aspergillus* rot of tomato also increased from 2013 to 2015, with the highest severity observed in district Pulwama followed by Kulgam, Srinagar and Anantnag, (Table 1, Fig 2). The rot severity in Srinagar ranged from 11.61% in 2013 to 15.87% in 2015. Likewise, in Pulwama, the rot severity ranged from 14.58% in 2013 to 18.45% in 2015. However, in district Anantnag, the severity of fungal rot ranged from 11.57% in 2013 to 15.87% in 2015 whereas in Kulgam, the rot severity ranged from 12.01% to 14.58% in 2015 respectively.

c. Incidence and severity of *Alternaria* rot of tomato caused by *Alternaria alternata* in some districts of Kashmir Valley.

It was found from the study (Table 1, Fig 1) that *Alternaria* rot of tomato caused by *Alternaria alternate* on tomato was prevalent in all the districts surveyed during the study. However, there was found variation in the incidence and severity of *Alternaria* rot of tomato in all the four districts during the period of study. The highest incidence was found in district Pulwama followed by Srinagar, Kulgam and Anantnag respectively. In Srinagar, the incidence of *Alternaria* rot of tomato ranged from 27.40% in 2013 to 26.93% in 2015. In Pulwama, the incidence of *Alternaria* rot ranged from 29.82% in 2013 to 26.60% in 2015. However, the incidence of rot ranged from 23.54% in 2013 to 23.35% in 2015 in Anantnag, whereas, the incidence of *Alternaria* rot of tomato ranged from 25.93% in 2013 to 21.74% in 2015 in Kulgam respectively.

The severity of *Alternaria* rot of tomato was highest in Srinagar followed by Pulwama, Anantnag and Kulgam districts respectively (Table 1, Fig 2). The rot severity in Srinagar ranged from 13.11% in 2013 to 16.80% in 2015. Likewise, in Pulwama, the rot severity ranged from 12.54% in 2013 to 16.63% in 2015. However, in district Anantnag, the severity of fungal rot ranged from 11.61% in 2013 to 15.87% in 2015 whereas in Kulgam, the rot severity ranged from 11.57% to 14.58% in 2015 respectively.

d. Incidence and severity of *Mucor* rot of tomato caused by *Mucor plumbeus* in some districts of Kashmir Valley.

It was revealed from the study (Table 1, Fig 1) that *Mucor* rot of tomato caused by *Mucor plumbeus* on tomato was prevalent in all the districts surveyed during the study. However, considerable variation was found in incidence and severity of *Mucor* rot of tomato in all the four districts during the period of study. The highest incidence was found in district Anantnag followed by Kulgam, Pulwama and Srinagar respectively. In Srinagar, the incidence of *Mucor* rot of tomato ranged from 21.66% in 2013 to 25.53% in 2015. In Pulwama, the incidence of *Mucor* rot ranged from 20.31% in 2013 to 26.85% in 2015. However, in Anantnag the incidence of rot ranged from 29.70% in 2013 to 27.33% in 2015 whereas the incidence of *Mucor* rot of tomato ranged from 27.23% in 2013 to 25.53% in 2015 in Kulgam respectively.

The severity of *Mucor* rot of tomato was highest in Kulgam followed by Anantnag, Srinagar and Pulwama districts respectively (Table 1, Fig 2). The rot severity in Srinagar ranged from 16.53% in 2013 to 14.18% in 2015. Likewise, in Pulwama, the rot severity ranged from 11.48% in 2013 to 19.97% in 2015. However, in district Anantnag, the severity of fungal rot ranged from 16.53% in 2013 to 15.96% in 2015 whereas in Kulgam, the rot severity ranged from 19.63% to 15.71% in 2015 respectively.

Table 1: Incidence and severity of fungal rot of tomato in some districts of Kashmir Valley.

Fungal rot	District	Disease Incidence (%)			Disease severity (%)		
		2013	2014	2015	2013	2014	2015
Penicillium rot	Srinagar	25.78	24.72	29.60	8.22	9.97	11.39
	Pulwama	24.42	25.50	29.68	18.38	14.27	15.87
	Anantnag	23.40	24.58	29.61	13.20	15.53	16.55
	Kulgam	24.31	25.86	26.33	12.11	16.63	17.04
	Mean	24.47	25.16	28.80	12.97	14.1	15.21
Aspergillus Rot	Srinagar	28.42	29.54	27.92	11.61	12.54	15.87
	Pulwama	28.85	30.04	27.94	14.58	16.63	18.45
	Anantnag	25.35	25.45	23.62	11.57	12.45	15.87
	Kulgam	24.72	26.27	20.41	12.01	14.27	14.58
	Mean	26.83	27.82	24.97	12.44	13.97	16.19
Alternaria Rot	Srinagar	27.40	28.14	26.93	13.11	15.71	16.80
	Pulwama	29.82	29.60	26.60	12.54	14.27	16.63
	Anantnag	23.54	25.58	23.35	11.61	12.54	15.87
	Kulgam	25.93	26.38	21.74	11.57	12.45	14.58
	Mean	26.67	27.42	24.65	12.20	13.74	15.97
Mucor rot	Srinagar	21.66	23.25	25.53	16.53	15.80	14.18
	Pulwama	20.31	23.26	26.85	11.48	11.45	9.97
	Anantnag	29.70	25.20	27.33	16.53	14.58	15.96
	Kulgam	27.23	29.77	25.53	19.63	18.16	15.71
	Mean	24.72	25.37	26.31	16.04	14.99	13.95

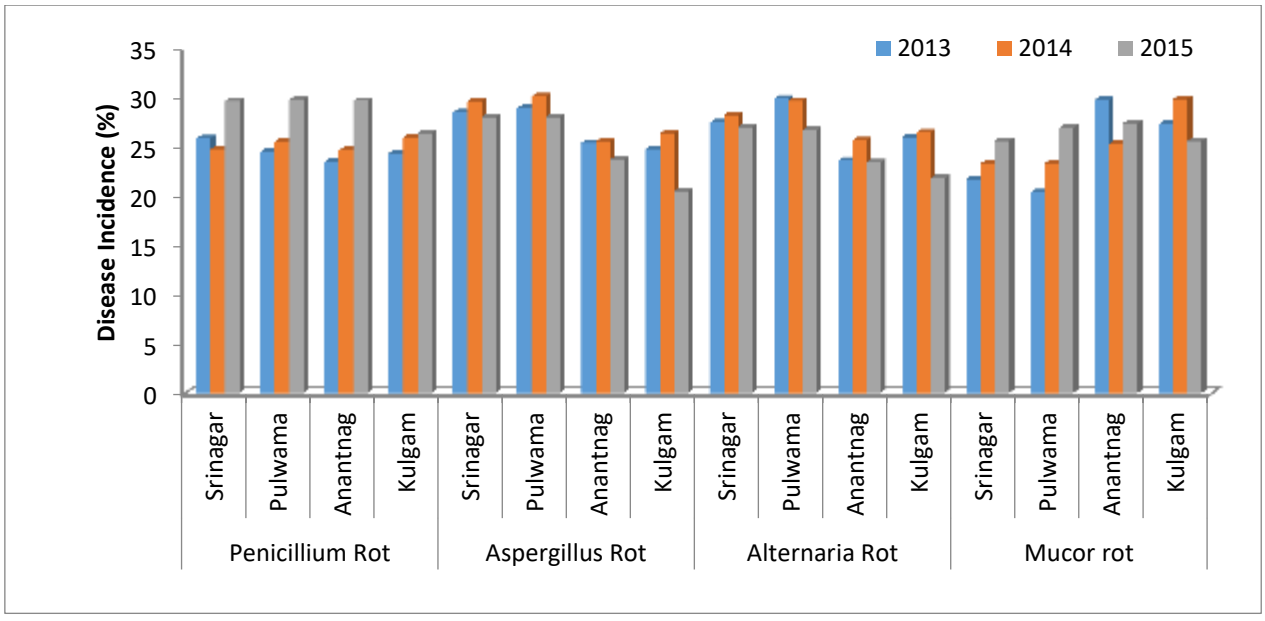

Figure 1: Incidence of fungal rot of tomato in some districts of Kashmir valley.

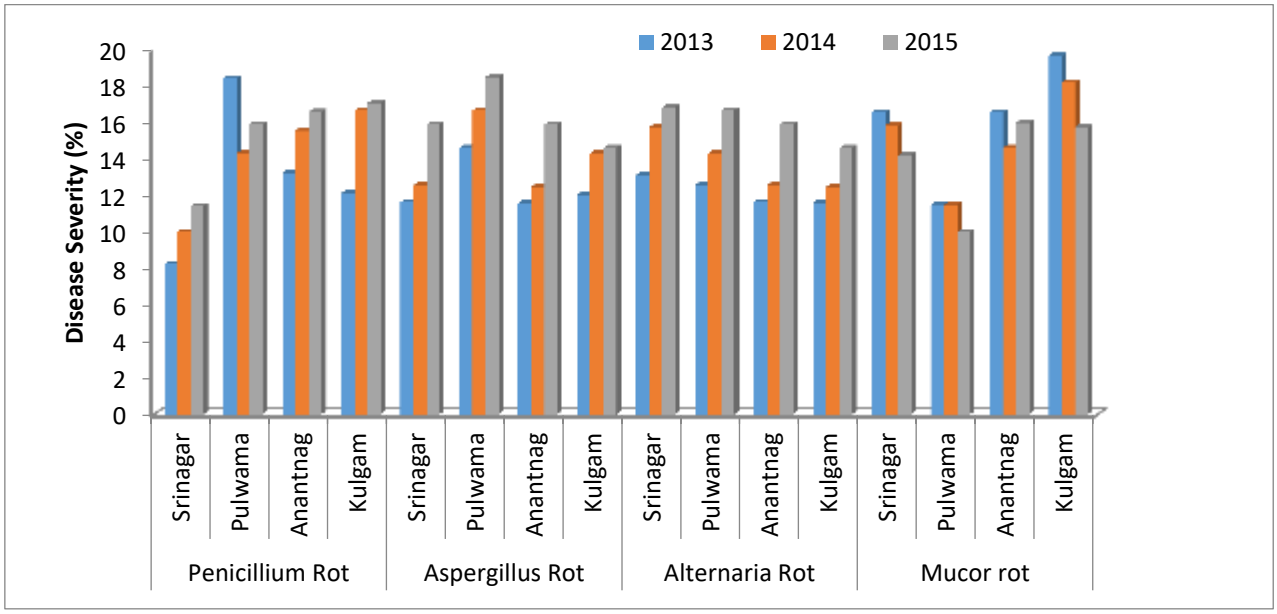

Figure 2: Severity of fungal rot of tomato in some districts of Kashmir valley.

3.1.2 Incidence and severity of fungal rot of brinjal in some districts of Kashmir Valley.

It was found from the present study that on brinjal, four fungal rot diseases such as *Penicillium* rot of brinjal caused by *Penicillium chrysogenum*, *Trichothecium* rot of brinjal caused by *Trichothecium roseum*, *Rhizoctonia* rot of brinjal caused by *Rhizoctonia solani* and *Aspergillus* rot of brinjal caused by *Aspergillus tenuis* were prevalent in district Srinagar, Pulwama, Anantnag and Kulgam respectively (Table 2, Fig 3, 4). The incidence and severity of fungal rot of brinjal is described separately as under:

a. Incidence and severity of *Penicillium* rot of brinjal caused by *Penicillium chrysogenum* in some districts of Kashmir Valley.

It was revealed from the study (Table 2, Fig. 3) that *Penicillium* rot of brinjal caused by *Penicillium chrysogenum* on brinjal was prevalent in all the four districts surveyed. However, significant variation in the incidence and severity of *Penicillium* rot of brinjal in all the four districts during the period of study. The highest incidence was found in district Srinagar and the incidence of rot ranged from 26.50% in 2013 to 29.75% in 2015 respectively. Similarly, incidence of *Penicillium* rot of brinjal varies from 24.58% in 2013 to 29.77% in 2015 in district Pulwama, from 24.58% in 2013 to 28.10% in 2015 in Anantnag and from 23.40% in 2013 to 26.30% in 2015 in district Kulgam respectively.

The severity of *Penicillium* rot of tomato also showed variation between 2013 to 2015, with the highest severity observed in district Pulwama followed by Anantnag, Kulgam and Srinagar (Table 2, Fig 4). In Srinagar, the rot severity ranged from 9.26% in 2013 to 11.24% in 2015. Likewise, in Pulwama, the rot severity ranged from 15.88% in 2013 to 18.49% in 2015, the severity of fungal rot ranged from 14.88% in 2013 to 17.90% in 2015 in Anantnag district whereas in Kulgam, the rot severity ranged from 14.65% in 2013 to 15.93% in 2015 respectively.

b. Incidence and severity of *Trichothecium* rot of tomato caused by *Trichothecium roseum* in some districts of Kashmir Valley.

It was observed from the study (Table 2, Fig 3) that *Trichothecium* rot of brinjal caused by *Trichothecium roseum* on brinjal was prevalent in all the areas/localities of districts Srinagar, Pulwama, Anantnag and Kulgam respectively. However, considerable variation was found in incidence and severity of *Trichothecium* rot of brinjal in all the four districts during the period of study. The highest incidence was found in district Pulwama followed by Kulgam, Srinagar and Anantnag respectively. Incidence of *Trichothecium* rot of brinjal in Srinagar ranged from 25.76% in 2013 to 28.78% in 2015.Similarly, percentage incidence of *Trichothecium* rot in Pulwama ranged from 25.61% in 2013 to 29.80% in 2015 respectively, whereas percentage incidence of rot in Anantnag district ranged from 22.13% in 2013 to 25.58% in 2015 respectively. In Kulgam district, the percentage incidence of rot ranged from 25.79% in 2013 to 29.55% in 2015 respectively.

The severity of *Trichothecium* rot of brinjal was highest in Pulwama followed by Srinagar, Kulgam and Anantnag (Table 2, Fig 4). The rot severity in Srinagar ranged from 10.78% in 2013 to 14.82% in 2015, whereas, severity of rot in Pulwama ranged from 11.32% in 2013 to 15.73% in 2015. However, in district Kulgam, the severity of fungal rot ranged from 9.94% in 2013 to 11.24% in 2015 respectively. The lowest severity was found in Anantnag district in which it ranged from 8.28% in 2013 to 10.24% in 2015 respectively.

c. Incidence and severity of *Rhizoctonia* rot of brinjal caused by *Rhizoctonia solani* in some districts of Kashmir Vallley.

It was found from the results (Table 2, Fig 3) that *Rhizoctonia* rot of brinjal caused by *Rhizoctonia solani* on brinjal was prevalent in all the four districts of Kashmir surveyed. But, there was found variation in the incidence and severity of *Rhizoctonia* rot of brinjal in all the four districts during the period of study. The highest incidence was found in district Kulgam followed by Anantnag, Pulwama and Srinagar respectively. Incidence of *Rhizoctonia* rot of brinjal in Kulgam ranged from 21.74% in 2013 to 24.42% in 2015. Similarly, percentage incidence of *Rhizoctonia* rot in Anantnag ranged from 18.19% in 2013 to 20.06% in 2015 respectively, whereas percentage incidence of rot in Pulwama district ranged from 16.95% in 2013 to 18.99% in 2015 respectively. In Srinagar district, the percentage incidence of rot ranged from 14.58% in 2013 to 19.67% in 2015 respectively.

The severity of *Rhizoctonia* rot of brinjal was highest in Kulgam followed by Anantnag, Pulwama and Srinagar (Table 2, Fig 4). The rot severity in Kulgam ranged from 14.66% in 2013 to 16.80% in 2015, whereas, severity of rot in Anantnag ranged from 13.16% in 2013 to 14.31% in 2015. However, in district Pulwama, the severity of fungal rot ranged from 10.86% in 2013 to 14.60% in 2015 respectively. The rot severity in Srinagar district ranged from 12.06% in 2013 to 15.75% in 2015 respectively.

d. Incidence and severity of *Aspergillus* rot of brinjal caused by *Aspergillus tenuis* in some districts of Kashmir Valley.

It was revealed from the present study (Table 2, Fig 3) that *Aspergillus* rot of brinjal caused by *Aspergillus tenuis* on brinjal was prevalent in all the areas/localities of districts Srinagar, Pulwama, Anantnag and Kulgam respectively. However, there was found variation in the incidence and severity of *Aspergillus* rot of brinjal in all the four districts during the period of study. The highest incidence was observed in district Pulwama followed by Srinagar, Anantnag and Kulgam respectively. The incidence of *Aspergillus* rot of brinjal in Pulwama ranged from 27.31% in 2013 to 29.53% in 2015 and in Srinagar it ranged from 27.30% in 2013 to29.70% in 2015 respectively. In district Anantnag, the incidence of *Aspergillus* rot ranged from 24.65% in 2013 to 28.06% in 2015. In Kulgam district, the percentage incidence of rot ranged from 23.55% in 2013 to 26.61% in 2015 respectively.

The severity of *Aspergillus* rot of brinjal was highest in Pulwama followed by Srinagar, Anantnag and Kulgam (Table 2, Fig 4). The rot severity in Pulwama ranged from 13.38% in 2013 to 16.60% in 2015, whereas, severity of rot in Srinagar ranged from 13.19% in 2013 to 15.73% in 2015. However, in district Anantnag, the severity of fungal rot ranged from 12.55% in 2013 to 14.80% in 2015 respectively. The rot severity in Kulgam district ranged from 11.45% in 2013 to 15.70% in 2015 respectively.

Table 2: Incidence and severity of fungal rot of brinjal in some districts of Kashmir Valley.

Fungal rot	District	Disease Incidence (%)			Disease severity (%)		
		2013	2014	2015	2013	2014	2015
Penicillium rot	Srinagar	26.50	25.54	29.75	9.26	10.94	11.24
	Pulwama	24.58	26.51	29.77	15.88	15.34	18.49
	Anantnag	24.58	26.33	28.10	14.88	15.78	17.90
	Kulgam	23.40	25.93	26.30	14.65	15.81	15.93
	Mean	24.76	26.07	28.48	13.66	14.46	15.89
Trichothecium rot	Srinagar	25.76	27.9	28.78	10.78	11.20	14.82
	Pulwama	25.61	27.90	29.80	11.32	13.15	15.73
	Anantnag	22.13	23.52	25.58	8.28	9.90	10.86
	Kulgam	25.79	26.32	29.55	9.94	10.88	11.24
	Mean	24.82	26.41	28.42	10.08	11.28	13.16
Rhizoctonia rot	Srinagar	14.58	16.63	19.67	12.06	13.16	15.75
	Pulwama	16.95	18.45	18.99	10.86	11.27	14.60
	Anantnag	18.19	20.02	20.06	13.16	14.23	14.31
	Kulgam	21.74	23.35	24.42	14.66	15.78	16.80
	Mean	17.86	19.61	20.78	12.68	13.61	15.36
Aspergillus rot	Srinagar	27.30	28.03	29.7	13.19	14.22	15.73
	Pulwama	27.31	28.78	29.53	13.38	14.31	16.60
	Anantnag	24.65	26.55	28.06	12.55	13.95	14.80
	Kulgam	23.55	25.55	26.61	11.45	12.46	15.70
	Mean	25.70	27.22	28.47	12.64	13.73	15.70

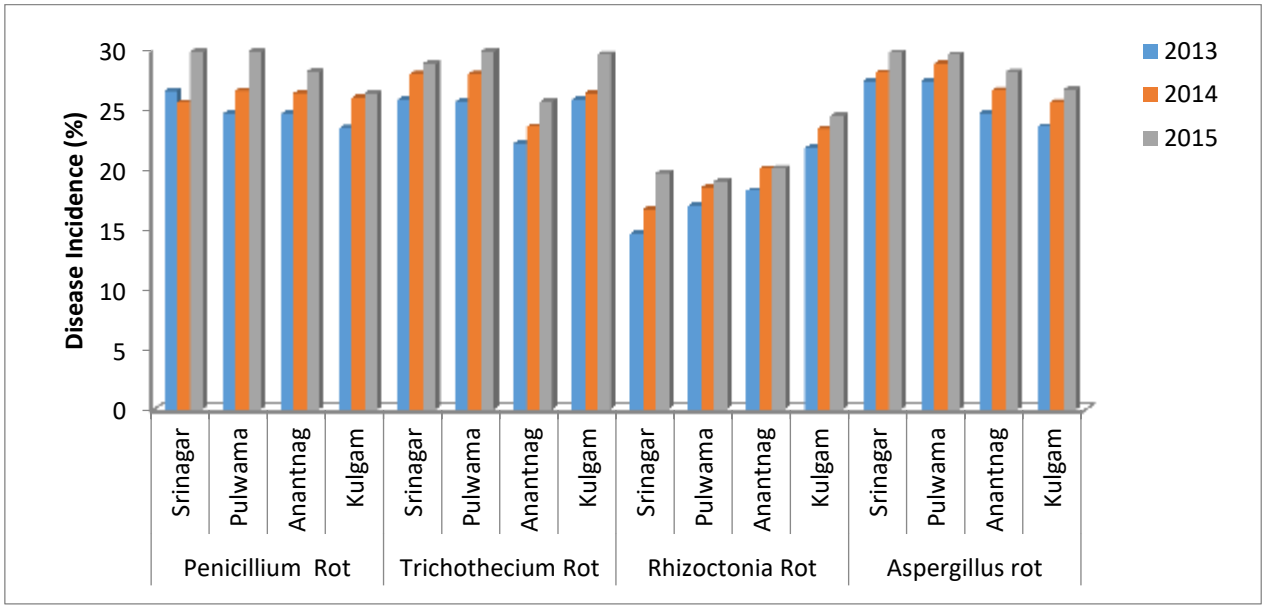

Figure 3: Incidence of fungal rot of brinjal in some districts of Kashmir valley.

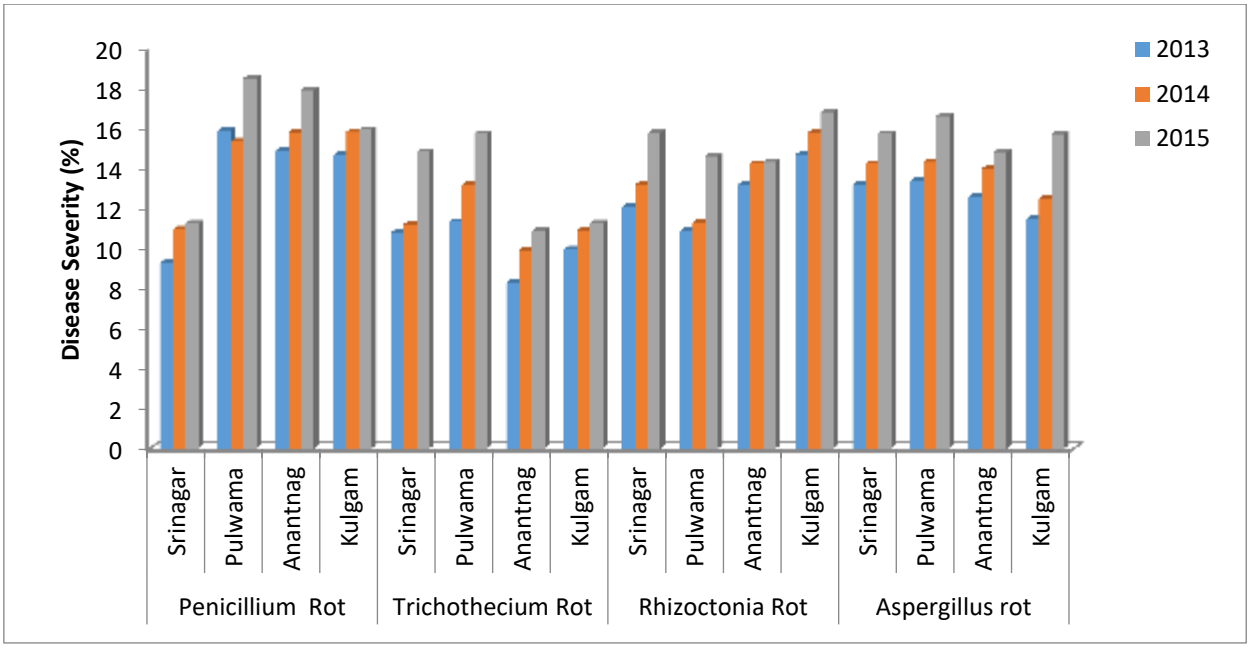

Figure 4: Severity of fungal rot of brinjal in some districts of Kashmir valley.

4. DISCUSSION

In the present study attempts was made to evaluate the incidence of fungal rot of vegetables such as tomato and brinjal in different areas/localities of Srinagar, Pulwama, Anantnag and Kulgam districts. It was clear from the results that fungal rot of tomato caused by *Penicillium expansum*, *Aspergillus niger*, *Alternaria alternata* and *Mucor plumbeus* was prevalent in storage houses, godowns and vegetable markets of all the four districts of Kashmir surveyed during the present study. However, there was found significant variation in the incidence and severity of fungal rot of tomato caused by fungi in all the four districts of Kashmir valley during the course of study. An increase or decrease in the incidence and severity was observed in all the districts surveyed during the study. The results clearly indicate that there was found a significant variation in the incidence and severity of fungal rot of tomato in different districts of Kashmir valley. Such variation in incidence and severity of fungal rot disease on vegetables as found in the present study have also been observed by[8]; [9,10] in some other parts of the world on tomato and other vegetables. Similarly, in case of brinjal, the incidence of fungal rot diseases caused by several species of fungi showed significant variation in incidence and severity in different districts of Kashmir Valley viz. Srinagar, Pulwama, Anantnag and Kulgam. Such variations in incidence and severity of fugal rot disease on vegetable have also been observed by [11,12,13]. Such variation in the incidence and severity may be due to variation in climatic conditions such as temperature, light, moisture etc which showed fluctuation throughout the year in the Kashmir Valley.

CONCLUSION

It was also concluded from the study that incidence of fungal rot diseases of tomato and brinjal showed significant variation in different areas/localities of Srinagar, Pulwama, Anantnag and Kulgam of Kashmir surveyed during study. Incidence and

severity of fungal rot of tomato and brinjal caused by several pathogenic fungi was from lowest to highest in all the surveyed districts of Kashmir Valley. The incidence and severity showed considerable increase during the period of study in Srinagar, Pulwama, Anantnag and Kulgam districts of Kashmir Valley and thus warrants effective management strategies.

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