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Epidemiological Studies on Chilli Anthracnose in Plain Zone of West Bengal

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ABSTRACT

A multi locations field trial of chilli (Bullet) was conducted for two years (April to August 2018 and 2019) to study on the disease severity of chilli anthracnose and simultaneously to determine a relationship of the disease severity with different weather factors in West Bengal. The observation on disease severity at different locations was taken at 7 days interval after appearance of the disease in the field and then the average disease severity of these locations was correlated with nine meteorological parameters (mean of each weather factor of 5 different locations) statistically. The highest disease severity was found at Karimpur (40.13) followed by Habra (39.18), Memari (38.63), Polba (38.33) and comparatively less was at Shantiniketan (36.31). The average disease severity of these five locations at the time of onset (54 DAT) was 6.6 which gradually increase and reach to 38.51 at the time of harvesting (131 DAT). The disease severity was found to be negatively correlated with T_{max} (-0.688), T_{min}(-0.755), wind velocity (-0.501) and gust (-0.551) while positively correlated with RH_{max} (0.888), RH_{min} (0.734), cloud (0.479), total rainfall (0.411) and pressure (0.479) significantly.

Keywords Chilli, Anthracnose, Disease severity, Meteorological parameters, Bullet.

INTRODUCTION

Chilli (*Capsicum annum* L.) is considered as a most important vegetable and spice cum cash crop cultivated throughout the world in tropical and sub-tropical area. It belongs to a family solanaceae. The origin of chilli seems to be Mexico. It is mainly grown in China, Pakistan, India, Thailand and Africa. In India it is cultivated in different states viz., Gujarat, Rajasthan, Tamil Nadu, Maharashtra, Karnataka, Nagaland, Andhra Pradesh, Assam, Orissa, West Bengal and parts of Madhya Pradesh. In West Bengal it is cultivated in an area of 63.60 ha with total production of 100 ton. But the production of chilli is hampered due to numerous biotic and abiotic factors. The biotic factors are fungi, bacteria, nematodes and viruses which cause devastating diseases reduced the quality and quantity

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Table 1. Disease severity of chilli anthracnose with respect to different weather factors at different time (Karimpur).

Observation dates	DAT	$T_{(max)}$ (^{0}C)	$T_{(min)}$ (^{0}C)	$RH_{(max)}$	$RH_{(min)}$	Wind velocity (km/h)	Gust (km/h)	Cloud (%)	Pressure	Total rainfall (mm)	PDI
15.06.2018	54	42	30	25	75	17	27	41	998	26.5	8.5
22.06.2018	61	38	30	38	72	17	22	46	1002	1.3	9.75
29.06.2018	68	33	27	58	85	15	22	68	1004	33.2	15.74
06.07.2018	75	35	28	52	85	9	16	63	999	30	17.45
13.07.2018	82	34	27	63	91	18	28	65	998	13.2	18.35
20.07.2018	89	35	30	56	79	17	28	46	996	12.3	21.18
27.07.2018	96	31	26	75	93	17	36	88	1000	31.6	27.56
03.08.2018	103	32	26	69	94	13	17	93	1001	59.5	34.09
10.08.2018	110	34	27	53	93	13	16	64	1003	14	35.23
17.08.2018	117	34	27	59	93	12	14	55	1001	9.7	36.45
24.08.2018	124	33	27	63	88	13	16	80	1001	13.3	38.85
31.08.2018	131	34	27	62	95	15	18	72	1002	14.1	40.13

of the produce and are often difficult to control (Nono-womdim 2001). The chilli anthracnose disease is caused by *Colletotrichum capisici* a significant constraint in chilli growing area appear in the field at maturity stage of fruit resulting sever loss of yield due to pre and post- harvest fruit rotting (Poulos 1992). This disease seems to be first reported in India from Coimbatore of Madras Presidency. Crop losses due to this disease may be 10-60% both in yield and quality of the chilli depending upon the varieties and weather parameters (Bansal and Grover 1969). So the appearance and development of the anthracnose disease in the severe form depend on the different weather factors. Hence our present experiment was conducted with the following objectives :

i. To study on the disease severity of chilli anthracnose at different locations in West Bengal.

ii. To determine a relationship of the different weather factors with the disease severity of chilli anthracnose so that effective control measures

Table 2. Disease severity of chilli anthracnose with respect to different weather factors at different time (Bardhaman).

Observation dates	DAT	$T_{(max)}$ (^{0}C)	$T_{(min)}$ (^{0}C)	$RH_{(max)}$	$RH_{(min)}$	Wind velocity (km/h)	Gust (km/h)	Cloud (%)	Pressure	Total rainfall (mm)	PDI
15.06.2018	54	44	31	17	61	28	47	12	999	0.1	6.39
22.06.2018	61	39	31	34	64	19	27	34	1003	1.9	8.24
29.06.2018	68	34	28	50	79	13	15	90	1004	26.7	13.93
06.07.2018	75	36	29	47	77	9	14	100	1000	31.1	16.73
13.07.2018	82	35	28	56	83	16	20	79	998	19.7	17.39
20.07.2018	89	36	30	49	76	20	29	58	997	18.2	19.45
27.07.2018	96	31	27	70	89	22	43	100	1001	51.3	26.13
03.08.2018	103	33	26	59	90	15	21	88	1001	49.2	32.39
10.08.2018	110	35	27	53	89	13	19	80	1003	36.1	33.43
17.08.2018	117	34	27	56	88	12	13	88	1001	26.8	35.72
24.08.2018	124	34	28	59	86	12	16	67	1001	22.1	37.36
31.08.2018	131	34	27	62	90	12	20	49	1003	41.8	38.63

Table 3. Disease severity of chilli anthracnose with respect to different weather factors at different time (Hooghly).

Observation dates	DAT	$T_{(max)}$ (^{0}C)	$T_{(min)}$ (^{0}C)	$RH_{(max)}$	$RH_{(min)}$	Wind velocity (km/h)	Gust (km/h)	Cloud (%)	Pressure	Total rainfall	PDI
15.06.2018	54	43	30	22	72	20	36	18	999	2.7	6.13
22.06.2018	61	37	30	41	73	18	23	50	1003	1.1	8.03
29.06.2018	68	34	27	52	80	14	22	71	1004	5.1	11.83
06.07.2018	75	36	28	47	82	11	17	42	1000	7.1	16.39
13.07.2018	82	35	28	57	86	17	19	80	999	5.1	16.91
20.07.2018	89	36	28	54	84	21	28	59	997	11.5	18.29
27.07.2018	96	32	27	67	91	22	26	99	1001	5.3	24.63
03.08.2018	103	33	26	60	89	13	18	100	1001	12.5	30.83
10.08.2018	110	34	27	56	91	14	21	63	1003	9.1	32.92
17.08.2018	117	34	27	58	90	10	15	85	1001	8.9	33.53
24.08.2018	124	33	28	62	88	15	20	52	1001	10.7	36.81
31.08.2018	131	33	27	64	92	16	20	46	1003	9.2	38.33

could be taken at an appropriate time to prevent this disease.

MATERIALS AND METHODS

To study on the disease severity (PDI) of chilli anthracnose in plain zone of West Bengal an roving survey was done in five districts viz., Nadia (Karimpur), Bardhaman (Memari), Hooghly (Polba), Birbhum (Shantiniketan), North 24 Parganas (Habra) for two years (April to August 2018 and 2019). The seedlings of chilli (Variety-Bullet) were transplanted in the month of April in four plots in each location. To determine the disease severity (PDI) of chilli anthracnose ten plants were selected randomly and tagged in each plot of each location. Then the percentage of infected area per fruit was recorded in each tagged plant through visual observation at an interval of seven days after appearance of the disease in the field. Then the disease severity of each plant as well as each plot was calculated following the 0–9 scale viz., 0 = no infection, 1 = 1–2%, 3 = 3–5%, 5 = 6–10%, 7 = 11–25% and 9 = >25% infected fruit area (Montri *et al.* 2009).

The disease severity was calculated using the fol-

Table 4. Disease severity of chilli anthracnose with respect to different weather factors at different time (Shantiniketan).

Observation dates	DAT	$T_{(max)}$ (^{0}C)	$T_{(min)}$ (^{0}C)	$RH_{(max)}$	$RH_{(min)}$	Wind velocity (km/h)	Gust (km/h)	Cloud (%)	Pressure	Total rainfall (mm)	PDI
15.06.2018	54	44	32	16	59	26	40	11	998	0.1	4.59
22.06.2018	61	39	31	32	60	20	27	31	1002	2.3	6.35
29.06.2018	68	34	28	50	78	13	17	83	1004	16.4	9.61
06.07.2018	75	36	30	46	73	8	13	100	1000	22.3	14.93
13.07.2018	82	34	28	56	81	17	21	84	999	18.8	15.39
20.07.2018	89	37	30	47	72	20	28	83	997	10.7	16.63
27.07.2018	96	32	27	68	87	21	31	90	1001	27.4	21.45
03.08.2018	103	33	27	61	88	16	22	90	1001	26.8	26.93
10.08.2018	110	35	28	53	87	12	18	83	1003	25.9	28.31
17.08.2018	117	34	27	56	89	13	15	81	1001	27.7	31.36
24.08.2018	124	34	28	62	85	12	16	76	1001	25.2	33.65
31.08.2018	131	34	28	60	88	13	19	60	1003	21.1	36.31

Table 5. Disease severity of chilli anthracnose with respect to different weather factors at different time (Habra).

Observation dates	DAT	$T_{(max)}$ (^{0}C)	$T_{(min)}$ (^{0}C)	$RH_{(max)}$	$RH_{(min)}$	Wind velocity (km/h)	Gust (km/h)	Cloud (%)	Pressure	Total rainfall (mm)	PDI
15.06.2018	54	42	30	23	76	22	38	22	999	6.2	7.39
22.06.2018	61	37	30	44	74	17	23	53	1003	1.5	9.23
29.06.2018	68	34	27	58	82	15	28	66	1004	18.2	14.97
06.07.2018	75	36	28	48	82	11	17	35	1000	21.2	17.15
13.07.2018	82	34	28	58	87	17	30	74	998	13.6	17.92
20.07.2018	89	35	28	56	85	22	36	57	997	16.7	20.33
27.07.2018	96	32	27	68	91	21	28	93	1001	18.6	26.72
03.08.2018	103	33	26	61	89	12	23	100	1001	43.8	33.63
10.08.2018	110	34	27	58	92	13	21	53	1003	9.4	34.49
17.08.2018	117	34	27	51	91	10	15	81	1001	20.1	35.93
24.08.2018	124	33	28	64	89	15	20	54	1001	19	37.94
31.08.2018	131	33	27	65	94	17	20	48	1003	10.4	39.18

lowing formula.

$$PDI = \frac{\text{Sum of the numerical values}}{\text{Number of chilli fruits inspected per plant} \times \text{Maximum disease rating value}} \times 100$$

After calculating the disease severity of each plot, average disease severity of four plots in each location at a specific day's interval was determined and simultaneously different meteorological parameters were recorded (Tables 1, 2, 3, 4, 5). Then the mean disease severity and mean of each weather factor of five locations were calculated and presented in (Table 6). The correlation of average disease severity and meteorological parameters was determined statistically (Table 7).

RESULTS AND DISCUSSION

The roving survey studies on disease severity of chilli anthracnose in five districts showed the similar type of result. Initially (54 DAT) disease severity was 8.5, 6.39, 6.13, 4.59 and 7.39 at Karimpur (Nadia), Memari (Bardhaman), Polba (Hooghly), Shantiniketan (Birbhum), Habra (North 24 Parganas) respectively. Then the disease severity was progressed gradually

Table 6. Disease severity of chilli anthracnose with respect to different weather factors at different time in plain zone of West Bengal.

Observation dates	DAT	$T_{(max)}$ (^{0}C)	$T_{(min)}$ (^{0}C)	$RH_{(max)}$	$RH_{(min)}$	Wind velocity (km/h)	Gust (km/h)	Cloud (%)	Pressure	Total rainfall (mm)	PDI
15.06.2018	54	43	30.6	20.6	68.6	22.6	37.6	20.8	998	15.7	6.6
22.06.2018	61	38	30.4	37.8	68.6	18.2	24.4	42.8	1002	8.64	8.32
29.06.2018	68	33.8	27.4	53.6	80.8	14	20.8	75.6	1004	21.38	13.21
06.07.2018	75	35.8	28.6	48	79.8	9.6	15.4	68	999	23.32	16.53
13.07.2018	82	34.4	27.8	58	85.6	17	23.6	76.4	998	17.14	17.19
20.07.2018	89	35.8	29.2	52.4	79.2	20	29.8	60.6	996	17.44	19.17
27.07.2018	96	31.6	26.8	69.6	90.2	20.6	32.8	94	1000	22.98	25.29
03.08.2018	103	32.8	26.2	62	90	13.8	20.2	94.2	1001	35.12	31.57
10.08.2018	110	34.4	27.2	54.6	90.4	13	19	68.6	1003	18.48	32.87
17.08.2018	117	34	27	56	90.2	11.4	14.4	78	1001	20.08	34.59
24.08.2018	124	33.4	27.8	62	87.2	13.4	17.6	65.8	1001	20.24	36.92
31.08.2018	131	33.6	27.2	62.6	91.8	14.6	19.4	55	1002	17.56	38.51

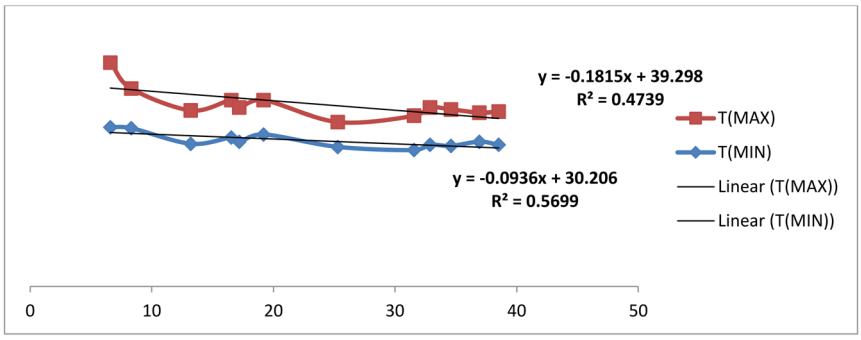

Fig. 1. Linear regression analysis of the effect of temperature ($_{max}$ and $_{min}$) on disease severity of chilli anthracnose.

in every place up to harvesting. At the time of harvesting (131 DAT) the highest disease severity (40.13) was found at Karimpur followed by Habra (39.18), Memari (38.63), Polba (38.33) and comparatively less was found at Shantiniketan (36.31). The average disease severity of five districts was 6.6 (54 DAT) and during harvesting (131 DAT) it was 38.51. This average value indicates the disease severity of chilli anthracnose in plain zone of West Bengal during summer season on this variety (Bullet).

Effect of temperature on disease severity of chilli anthracnose

The relationship between temperature (Max and Min) and disease severity was studied for two years and found a negatively correlation among them (Table 7). The effect of temperature (Max and Min) on disease severity was analyzed and expressed by the two equations $Y = -0.18X + 39.29$ ($R^2 = 0.473$) (T_{max}) and $Y = -0.093X + 30.20$ ($R^2 = 0.569$) (T_{min}) where Y = disease severity and X = temperature (Max and Min). Here R^2 value indicates the contribution of temperature (T_{max} and T_{min}) was 47.3% and 56.9% respectively on the disease severity (Fig. 1).

Effect of wind velocity and gust on disease severity of chilli anthracnose

The studies on a relationship of wind velocity and gust with disease severity for two years revealed that there was a negative correlation (Table 7). The effect of wind velocity and gust on disease severity

Table 7. Correlation matrix of diseases severity with weather factors in plain zone of West Bengal.

Variables	$T_{(max)}$	$T_{(min)}$	$RH_{(max)}$	$RH_{(min)}$	Wind velocity	Gust	Cloud (%)	Pressure	Total rainfall	PDI
$T_{(max)}$	1	0.892	-0.981	-0.861	0.468	0.512	-0.897	-0.527	-0.809	-0.688
$T_{(min)}$		1	-0.871	-0.940	0.513	0.500	-0.868	-0.706	-0.846	-0.755
$RH_{(max)}$			1	0.888	-0.372	-0.426	0.853	0.502	0.814	0.734
$RH_{(min)}$				1	-0.480	-0.494	0.753	0.554	0.755	0.888
Wind velocity					1	0.967	-0.411	-0.383	-0.136	-0.501
Gust						1	-0.394	-0.261	-0.097	-0.551
Cloud (%)							1	0.712	0.928	0.479
Pressure								1	0.764	0.411
Total rainfall									1	0.479
PDI										1

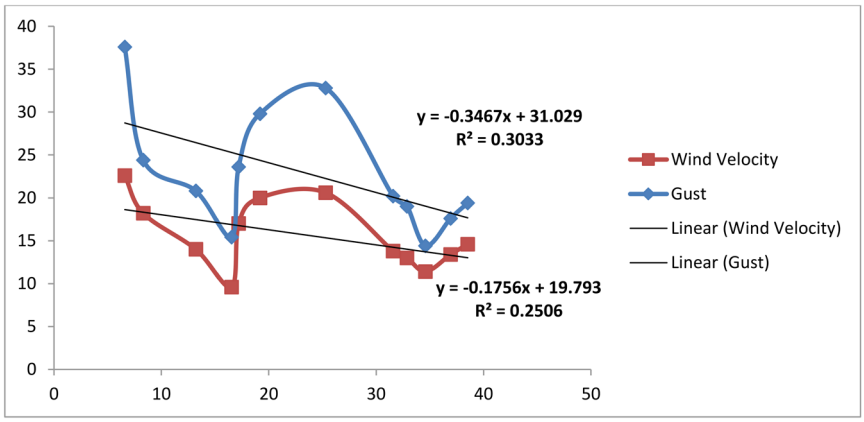

Fig. 2. Linear regression analysis of the effect of wind velocity and gust on the disease severity of chilli anthracnose.

was analyzed and expressed by the following two equations Y= –0.175X + 19.79 (R^2 = 0.250) and Y= –0.346X+31.02 (R^2 =0.303) respectively where Y= disease severity and X = wind velocity and gust. Here R^2 value indicates the contribution of wind velocity (25%) and gust (30.3%) on disease severity (Fig. 2).

Effect of cloud, rainfall, relative humidity and pressure on disease severity of chilli anthracnose

Observation on a relationship of cloud, rainfall, relative humidity and pressure with disease severity of chilli anthracnose showed that there was a positive correlation among them (Table 7). The effect of these weather factors (cloud, rainfall, relative humidity and pressure) on disease severity was analyzed and expressed by the following equations Y= 0.869X +46.29 (R^2 =0.229) (cloud), Y= 0.224X+14.58 (R^2 =0.169) (rainfall), Y= 0.647X + 68.39 (R^2 = 0.789) (RH_{max}) Y = 0.844X + 33.33 (R^2 = 0.538) (RH_{min}) and Y=0.064X + 998.9 (R^2 =0.098) (pressure) respectively where Y= disease severity and X=cloud, rainfall, relative humidity and pressure where R^2 value indicate the contribution of cloud (22.9%), rainfall (16.9%), RH_{max} (78.9%), RH_{min} (53.8%) and pressure (9.8%) on disease severity (Figs. 3, 4 and 5).

All these findings are similar with Begum *et al.* (2017) who reported that disease severity was positively and significantly correlated with RH_{max} (0.681) and RH_{min} (0.669) while other factors like T_{max} (–0.799), T_{mim} (–0.781), wind velocity (–0.872) and

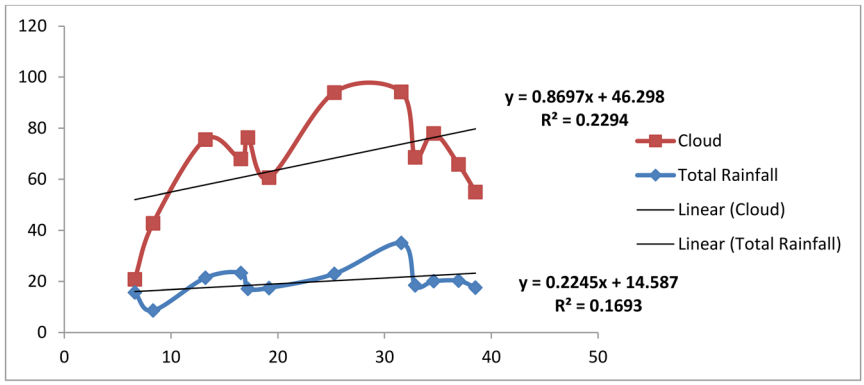

Fig. 3. Linear regression analysis of effect of cloud and total rainfall on the disease severity of chilli anthracnose.

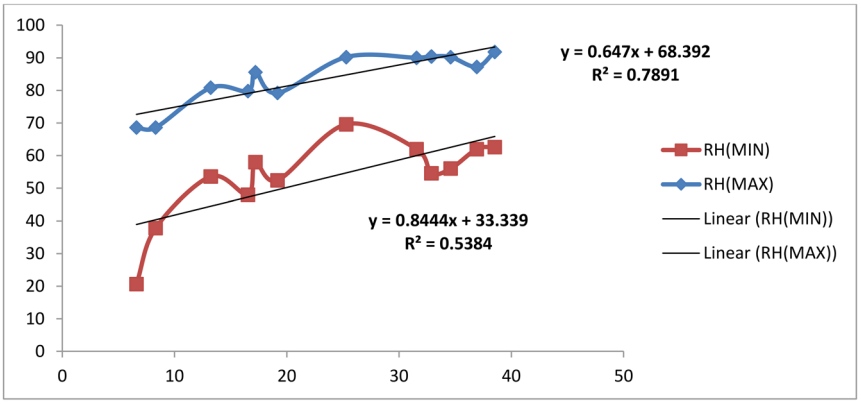

Fig. 4. Linear regression analysis of effect of $RH_{(max)}$ and $RH_{(min)}$ on the disease severity of chilli anthracnose.

vapor pressure (–0.717) were negatively and highly correlated with disease severity.

CONCLUSION

The findings of the experiment revealed that there was minute variability in the disease severity of chilli anthracnose at different locations in West Bengal. Highest disease severity was observed at Karimpur followed by Habra and very lowest at Shantiniketan. The average disease severity at the time of onset and harvesting was 6.6 and 38.51 respectively in West Bengal. The disease severity was positively correlated with relative humidity, cloud, rainfall, and pressure while negatively correlated with temperature, wind velocity and gust. Thus the weather factors play a major role for the development of pandemic of chilli anthracnose and the relationship of these weather factors with disease severity helps the agro advisory services for the farmers so that they can take the suitable management practices at appropriate time.

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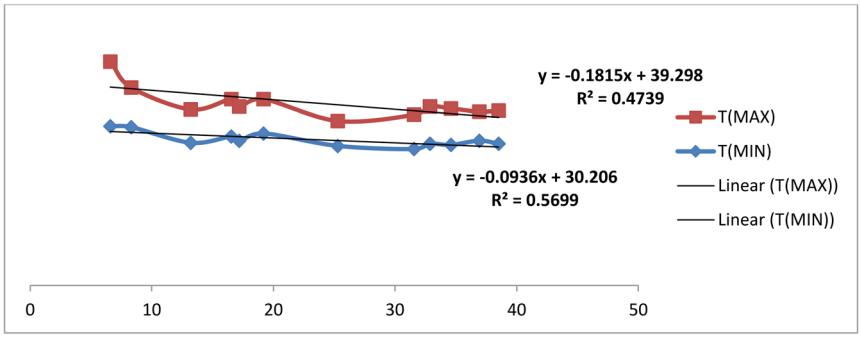

Fig. 5. Linear regression analysis of the effect of pressure on the disease severity of chilli anthracnose.

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