RESEARCH ARTICLE

IMPACT OF ABIOTIC FACTORS AND AGE OF HOST PLANT ON PURPLE BLOTCH OF ONION CAUSED BY *ALTERNARIA PORRI* (ELLIS) AND ESTIMATION OF YIELD LOSSES

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Abstract: An experiment was conducted on" Impact of abiotic factors and age of host plant on purple blotch of onion *(Allium cepa* L.) caused by *Alternaria porri* (Ellis) and estimation of yield losses "was carried out in Department of Plant Pathology, cage house and experimental field of Horticulture farm, Rajasthan College of Agriculture, Udaipur during 2014-2015. Sixty-days-old plants were more susceptible for infection of *A. porri*. However, susceptibility increased with increased age and after 60-days age decreased in susceptibility was recorded. In field trial conducted for yield loss estimation revealed that maximum yield loss (50.11%) was obtained in control plots followed by one, two and three spray of Mancozeb @ 0.2 per cent concentration. In relation to environmental factors study, temperature ranged from 13 to 32°C, relative humidity more than 75 per cent, wind velocity 2.4 Kmph, sunshine 8.4 hrs and optimum rainfall was found favourable for purple blotch disease development.

Keywords: Purple blotch, Onion, Abiotic, Age of host, Yield loss

INTRODUCTION

Onion (*Allium cepa* L.) belongs to family Amaryllidaceae, is a bulbous, biennial herb, rightly called as "Queen of kitchen". It is one of the most important vegetable cum condiment crop grown throughout the world. In India onion is cultivated in three seasons mainly – *Kharif*, late *Kharif* and *Rabi*. *Rabi* accounts for 60 per cent production and other two season's accounts for 20 per cent each. India occupies second rank in productivity next to China with an area of 12.04 lakh hectares with an annual total production of 194.02 lakh tons and an average productivity of 16.1 mt/ha. In Rajasthan, it is cultivated in 5.75 lakh hectares with a total production of 7.05 lakh tons and productivity of 12.3 mt/ha.([1]Anonymous, 2013-14).Onion crop suffers from number of disease among them purple blotch of onion caused by *A. porri* (Ellis) is the most destructive disease, prevalent in almost all onion growing areas of the world causing heavy losses under field conditions and is the major constraints to the onion production and due to this disease yield loss ranging from 2.5 to 87.8 per cent during *Kharif* season ([2]Srivastava *et al*., 1994). The fungus attacks both leaves and flower stalk ([3] Bock, 1964), reducing foliar production by 62-92% ([4] Suheri and Prince, 2001). The disease can cause a yield loss of 30% ([5] Everts and Lacy, 1990) and 100% of the seed crop, when the weather is favourable ([6] Daljeet *et al*., 1992 and Schwartz, 2004). The yield loss of onion in India due to this disease under favorable conditions varies from 5.0 to 96.5 per cent ([7]Gupta and Pathak, 1988) and 97 per cent ([8] Lakra, 1999).

Keeping in view, economic importance and yield losses caused by purple blotch present investigation were undertaken.

MATERIAL AND METHOD

Effect of plant age on disease development

A pot experiment was laid out in completely randomized design with five replications. Each pot had four plants. The susceptible onion cultivars Nasik red seedlings were transplanted in pots. After 15 days of transplanting (i.e. 15 day plant age) five pots were taken and inoculated with culture of *A. porri* by spray inoculation technique. Inoculated plants were kept in humid chamber for 20 hrs and then transferred to cage house and high humidity was maintained throughout the disease development period by regular spraying with water. Observations for disease severity were recorded periodically after 10 days of inoculation on 0-5 disease rating scale given by [9] Sharma (1986). The process was repeated similarly for 30, 45, 60, 75 and 90 day plant age.

The details of 0-5 rating scales is listed below:

Per cent area covered	Score
No disease symptom	0
A few spots towards tip covering 10 per cent leaf area	1
Several purplish brown patches covering upto 20 per cent of leaf area	2

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Several patches with paler outer zone covering upto 40 per cent leaf area	3
Leaf streaks covering upto 75 per cent leaf area or breaking of the leaves from center and	4
Complete drying of the leaves or breaking of leaves from center	5

The per cent disease index (PDI) was calculated using following formula given by [10] Wheeler 1969 :

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of all individual disease rating}}{\text{Total No. of plant assessed} \times \text{Maximum rating}} \times 100$$

Estimation of losses of onion bulb under field conditions

The losses caused by a disease vary with the host pathogen combination and the disease severity. Since limited information is available on the losses caused by *A. porri* in onion, field trials were conducted in *Rabi* 2014-15 to assess the reduction in yield under field conditions. The experiment was conducted taking local susceptible land race(Nasik red) of onion. The seedlings were prepared in nursery and after attaining one month age these were transplanted in field in 3 x 2 m size plots, taking 15 cm row to row distance and 10 cm plant to plant distance. Recommended agronomical practices for fertilizers (N-100, P-50 and K-100 kg ha^{-1}) and for weeds mechanical removal was followed. The onion plants were inoculated uniformly with the pure culture of *A. porri*. In first treatment one spray with Mancozeb @ 0.2 per cent concentration, similarly, two and three spray in 2^{nd}& 3^{rd} treatments with the same fungicide were given and 4^{th} treatment was maintained as untreated control. Five replication of each treatment were maintained and treatments were planned in randomized block design. The inoculations were done in the late evening.Spore suspension was prepared by gently flooding the scraping dislodge conidia 7 days old culture with distilled water (1:1) in a warring blender and filtering through muslin cloth. The desired inoculum density 1×10^3 conidia ml^{-1} was prepared with the help of a haemocytometer. The inoculum was prepared fresh just before inoculations in the field. These were spray-inoculated on 45 days-old plants with the help of hand held sprayer to the run off level.

Observations for disease severity were recorded periodically (15 days after inoculation) by visual scoring as per the standard continuous rating 0-5 scale ([9] Sharma, 1986). Numbers of plants in each score were recorded and the PDI in each plot was determined as:

$$PDI = \frac{n\,x1 + n\,x2 + n\,x3 + n\,x4 + n\,x5}{N} \;X\; \frac{100}{\text{Maximum disease score (5)}}$$

Where,

n = Number of plants in each score, 0-5 = disease score

N = Total number of plant under observation

At maturity, plants from each plot were harvested and bulb yield/ plot were determined. The per cent losses in bulb yield were calculated by using formula given by [11] Klem (1940) as:

$$Q = \frac{a - b}{b} \times 100$$

Where,

a = Mean yield per plot from healthy plant

b = Mean yield per plot from diseased plant

Q = Per cent loss in yield

Epidemiological studies

Epidemiology of the disease, aerobiological studies such as appearance of spores and development of disease were carried out. Study on air borne conidia of *A. porri* was carried out in cage house throughout the cropping season after 30 days of inoculation under different environmental conditions to understand the development of the disease. The pathogen released the inoculum continuously in the form of conidia throughout the crop season. Later on intensity of purple blotch were correlated in relation to weather parameters. The weather data *i.e*. maximum and minimum temperature, morning and evening relative humidity, total rainfall per week, total rainy days per week, wind velocity (Kmph) and sunshine hrs per day were collected from agronomy farm observatory at RCA, Udaipur.

RESULT AND DISCUSSION

Effect of plant age on disease development

As the age of plants of cv. Nasik red increased, the percentage of leaf area showing symptoms and the percentage of defoliation increased. The most susceptible age of onion plants was found to be 60-days with 52.48 PDI. Inoculation at 30, 45-days-old plants resulted in 18.60 and 33.86, PDI respectively. At the later stage (75 and 90-days-old) onion cultivar showed decline in PDI 50.40 and 43.72 while no disease occurred at 15-days-old plant age. Increased susceptibility to infection with increasing host age has been reported in many *Alternaria*–host systems, such as *A. brassicae* and *A. brassicicola* on brassica crops ([12] Babadoost & Gabrielson, 1979), *A. porri* on onions ([13]Gupta & Pathak, 1986) and *A. macrospora* on cotton ([14] Rotem *et al*., 1990). [15]

Kareem *et al*. (2012) studied the onion plants at different age*viz*., 15, 30, 45, 60 and 75 days were inoculated separately with conidial suspension of *A. porri*. With the increased host age there was a significant increased in disease development. Highest PDI (54.43) recorded at 60 days age followed by 75 days (51.75), 45 days (36.25) and 30 days (28.83 PDI) whereas 15 days age plant showed less PDI (21.08).(Table 1)

Estimation of losses of onion bulb under field conditions

All the treatments resulted in higher yield ranging from (12.02-16.04 kg/plot) over the untreated control (8.98 kg/plot). In the inoculated control plots, onion yield was 8.98 kg/plot. The maximum yield loss (50.11%) was obtained in control plots followed by one spray (33.22%), two spray (22.38%) and three spray (10.89%). Purple blotch of onion has been reported to cause heavy losses in yield and as per reports it causes 20-25 per cent yield loss ([16] Thind and Jhooty, 1982). In present investigation Mancozeb @ 0.2 per cent concentration was used as protective spray and untreated control was also maintained, taking three treatments of one, two and three sprays. PDI was also recorded and based on PDI it was found that three sprays of Mancozeb @ 0.2 per cent concentration at 10 days interval was best to control the disease with least PDI *i.e*. 26.04 with maximum yield of 16.04 kg/plot and yield loss 10.89 per cent respectively. Loss increased with the decreased in number of sprays *viz.*, two sprays with PDI 30.14 per cent and losses in yield 22.38 per cent followed by one spray with 33.22 per cent over healthy plots. Spray schedule and frequency is decisive in the disease management. Huq *et al.* (1999) showed average yield reduction in garlic cv. GC-018 with 21.54 per cent when yield was taken in different disease severity levels. [17] Upmanyu and Sharma (2007) observed extent of seed yield losses due to purple blotch of onion and reported that as the PDI increased yield of seed decreased. [18]Singh *et al* (2014) reported yield losses upto 58.44 per cent due to *A. lini* and *A. linicola*.(Table 2)

Epidemiological study

The PDI were recorded from December third week (standard week 51) to April fourth week (standard week 17) and February weeks were found favourable for initiation of purple blotch disease development in onion, whereas December third week was found least favourable. Maximum disease index was observed during February second, third, fourth and first week of March, there was increase in mean PDI 28.5 to 39.2, 39.2 to 47.8, 47.8 to 56.9 and then 56.9 to 64.7, respectively. Subsequently in later weeks disease declined with mean PDI 64.9 to 60.2, 60.2 to 51.3, 51.3 to 46.5 and 46.5 to 36.7 in second, third, fourth and fifth week of March, respectively and finally disease declined with mean PDI 17.4 in third week of April.

Table 1. Effect of plant age on purple blotch development on onion cultivar Nasik red

S.No.	Plant age (days)	Per cent disease index (PDI)*
1.	15	0.00 (0.00)
2.	30	18.60 (25.54)
3.	45	33.86 (35.58)
4.	60	52.48 (46.42)
5.	75	50.40 (45.23)
6.	90	43.72 (41.39)
SEm±		0.78
CD (P = 0.05)		2.29
CV (%)		5.28

*Mean of five replications

Figures in parentheses are arcsine √per cent angular transformed values

Table 2. Yield losses in onion due to *Alternaria porri* in field during *Rabi* 2014-15

S.No.	Treatments	Per cent disease Index (PDI)*	Bulb yield* (kg/plot)	Per cent loss in bulb yield
1.	Healthy plot	0.00	18.00	0.00
2.	Three spray	26.04 (30.68)	16.04	10.89 (19.27)

3.	Two spray	30.14 (33.29)	13.97	22.38 (28.23)
4.	One spray	34.37 (35.88)	12.02	33.22 (35.20)
5.	Control	52.81 (46.61)	8.98	50.11 (45.06)
	SEm±	0.711		1.18
	CD (P = 0.05)	2.04		3.49
	CV (%)	3.97		9.01

*Mean of five replications;
Figures in parentheses are arcsine √per cent angular values

Table 3. Effect of environmental factors in relation to purple blotch disease of onion during *Rabi* 2014-15 at RCA Udaipur

Standard week	Meteorological Weeks 2014, 2015	Average Temperature (°C)		Average Relative Humidity (%)		Wind velocity (Kmph)	Sunshine (hrs)	Avg. rainfall (mm)	Rainy days (days)	PDI* (%)
		Max.	Min.	Max.	Min.					
51	17 Dec-23 Dec	22.6	5.0	86.9	31.4	1.6	7.7	0.0	0	0.0
52	24 Dec-31 Dec	22.9	4.8	84.1	26.9	1.9	8.6	0.0	0	0.5
1	1 Jan-7 Jan	21.8	8.8	90.4	43.4	3.0	5.3	3.2	2	5.5
2	8 Jan-14 Jan	27.4	7.7	85.7	25.1	1.2	8.7	0.0	0	8.2
3	15 Jan-21 Jan	22.8	6.9	91.3	36.0	2.0	7.4	6.0	1	12
4	22 Jan-28 Jan	21.0	9.1	88.1	52.4	2.9	4.9	6.2	1	20.4
5	29 Jan-4 Feb	25.2	6.9	86.9	28.6	2.0	8.8	0.0	0	28.5
6	5 Feb-11 Feb	25.3	8.6	87.9	36.6	2.1	8.2	0.0	0	39.2
7	12 Feb-18 Feb	29.8	10.6	78.9	30.7	2.3	9.0	0.0	0	47.8.
8	19 Feb-25 Feb	32.5	13.7	78.0	31.0	2.4	8.4	0.0	0	56.9
9	26th Feb-4thMarch	25.0	10.3	76.90	33.00	3.7	6.8	13.2	2	64.7
10	5March-11March	28.0	11.3	76.7	27.6	2.7	8.9	0.0	0	60.2
11	12March-18March	28.6	14.0	79.4	30.4	3.1	7.3	10.6	3	51.3
12	19March-25March	33.8	15.9	68.6	24.7	2.1	9.2	0	0	46.5
13	26March-1April	36.3	19.5	66.1	19.4	3.4	7.2	0	0	36.7
14	2April-8April	34.1	21.7	53.9	25.7	5.8	7.8	0	0	27
15	9April-15April	32.6	18.5	60.9	30.9	3.8	7.4	15.6	3	20.2
16	16April-22April	37.9	22.2	37.0	14.4	4.7	7.4	0	0	17.4
17	23April-29April	39.4	24.3	28.9	12.0	6.0	8.5	0	0	14.3

*Mean of five replications

Temperature from 13 to 32°C was found most favourable however, maximum temperature showed positive correlation (r = +7.09) while minimum temperature showed negative correlation (r = -2.19) more than 40°C and less than 12°C was found not favourable. Relative humidity more than 75 per cent was found more favourable, however morning and evening relative humidity showed positive correlation (r = +2.38 and +1.12). Optimum rainfall was favourable for purple blotch of onion, however, rainfall showed positive correlation with spread while rainy days showed negative correlation. Wind velocity and sunshine hrs showed positive correlation. However, [19] Bassey and Gabrielson (1983) studied plants inoculated with *A. brassicicola* developed symptoms most quickly at 25°C, while seedlings raised from infected seeds developed symptoms most quickly at 30°C. [15] Kareem *et al*. (2012) reported infection of *A. porri* on onion over a temperature range of 15 to 35°C, with maximum infection at 25°C. The optimum RH for the infection of onion by *A. porri* was found to be 95 per cent, though disease development occurred over the range of 75 to 100 per cent relative humidity. [20] Mohammad and Dabbas (2012) studied the influence of environmental factors on the development of purple blotch of onion under field conditions; temperature and RH play an important role in the disease development. Range of temperature 25.50-28.00 and 26.50-27.20, relative humidity 88-76 per cent and 80-78 per cent favoured highest disease incidence during 2008 and 2009 seasons, respectively. (Table 3)

The present data of experiment are again confirmed and strongly supported the results obtained by earlier workers on this disease.

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