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RESEARCH ARTICLE

MANAGEMENT OF PURPLE BLOTCH COMPLEX OF ONION (*ALLIUM CEPA* CV RED CREOLE) UNDER FIELD CONDITION IN RUKUM-WEST, NEPAL

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ABSTRACT

A field experiment was conducted in Chaurjahari Municipality, Rukum-west, Nepal during the rabi season of 2019 to study the management of purple blotch complex of onion through chemicals and bio fungicides. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications of each treatment. Six different chemical fungicides; Hexaconazole, Tebuconazole, Mancozeb+Cymoxanil, Dimethomorph, Chlorothalonil, Carbendazim and one biological fungicides Trichoderma were evaluated in field condition against *Alternaria porri* and *Stemphylium vesicarium* for effective control of purple blotch complex. The fungicides were spread in fortnight interval and data were collected on biometric parameters like plant height, number of umbel stalk, umbel diameter; yield contributing characters like thousand seed weight and yield of onion. Likewise, data on disease incidence and disease severity were also recorded. Hexaconazole and Mancozeb + Cymoxanil were proved to be best in controlling this complex with the Percent Disease Control (PDC) of 84.45 percent and 80.00 percent respectively. The highest yield 878.7 kg/ha and thousand seed weight 3.72gm were recorded from Hexaconazole treated plot followed by Mancozeb + Cymoxanil with yield and thousand seed weight of 878.3kg/ha and 3.64gm respectively. The economic analysis of fungicides was also done where Hexaconazole at 0.1 percent concentration was found most economic with the Benefit Cost ratio of 3.02. Similarly, the study of weather parameter in relationship to disease occurrence was done, the coefficient of multiple determinants (R²) obtained was 0.7858 indicating 78.58 percent of variation in purple blotch development explained by the different weather parameter under study.

KEYWORDS

Purple blotch Complex, Fungicides, Hexaconazole, Mancozeb + Cymoxanil, Yield.

1. INTRODUCTION

Onion (*Allium cepa* L.) (2n=16) often called as "Queen of kitchen" is one of the oldest known and an important vegetable crop grown in Nepal (Pareek et al., 2017; Galande and Simon, 2019). It is valued for its distinctive pungent smell (Ravichandra, 2012). Medicinal values of onion are innumerable and is one of the ancient crops being utilized in medicine. Extract of onion is used as antibacterial, antifungal, anti-helmenthic, anti-inflammatory, anti-septic and anti-spasmodic (Jhala. Over years, onion has gained the importance of a cash crop rather than vegetable crop because of its very high export potential.

Several factors have been identified for the low productivity of onion in Nepal. The most important factors responsible are the diseases like purple blotch, downy mildew, *Stemphylium* blight, basal rot and storage rots and non-availability of varieties resistant to biotic and abiotic stresses (Savitha et al., 2014; Meena et al., 2017). Purple blotch, commonly known as leaf blotch, caused by *Alternaria porri* is noted as the most serious disease of onion affecting both bulb and seed production by breaking floral stalks (Islam and Faruq, 2006; Veeraghanti et al., 2017). Nowadays, *Stemphylium botryosum*, the causal agent of white blotch of onion are

indirectly involved with the causation of purple blotch of onion. *Stemphylium botryosum* initiate the infection and *Alternaria porri* facilitates for causing purple blotch and hence the disease is treated as purple blotch complex (Nainwal and Vishunavat, 2016; Akter et al., 2015; Ali et al., 2016).

In Nepal, few attempts have been made to find out the suitable control measures of this disease. The varieties grown in the country are highly susceptible to the disease. Role of environmental factors on disease development has not yet been studied systematically. Therefore, quite a little information is available on fungicidal control; and mostly those are on bulb production only but not on seed production. Some of the fungicides used worldwide and found effective are Chlorothalonil 75% WP, Mancozeb 75% WP, Propineb 70% WP, Difenconazole 25% EC, Propiconazole 25% EC and Hexaconazole 5% EC (Bachkar and Bhalckar, 2018). A good number of fungicides are yet to be assayed against this disease. Thus, the present study was undertaken to screen out the effective fungicides for the management of the purple blotch complex of onion for seed production.

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2. MATERIALS AND METHODS

In order to study the effectiveness of fungicides in controlling the disease, eight different treatments were included in the trial. The treatments were replicated three times in a Randomized Complete Block Design. Thus, total 24 plots were there. The size of individual plot was 3 × 1.5 m. The spraying was done as soon as the plant has shown the initial symptoms. The sprayings were done at fortnightly intervals (15 days) till the crop matured and onion seed was harvested. The treatments are tabulated.

Treatments	Chemical name	Trade name	Dose (%)	Active ingredient
T ₁ (control)	Plain Water	-	-	-
T ₂	Carbendazim	Bavistin	0.2%	50%WP
T ₃	Tebuconazole	Carapace	0.1%	25.9%EC
T ₄	Hexaconazole	Roshan plus	0.1%	5%SC
T ₅	Chlorothalonil	Royal care	0.2%	75%WP
T ₆	Dimethomorph	Kingstival	0.25%	50%WDG
T ₇	Mancozeb+ Cymoxanil	Real-mil	0.3%	64%WP +8% WP
T ₈	Tricoderma liquid	Trivi	0.3%	SL

The 0 to 5 disease scoring scale was used to estimate the disease severity (PDI-Percent Disease Index) of purple blotch complex of onion for each unit plot under each treatment. The scale followed was given as described below (Islam, 2013):

S.N	Score	Severity
1	0	no disease symptoms in the plant
2	1	a few spots towards the tip, covering less than 10% leaf area
3	2	several dark purplish brown patches covering less than 20% leaf area
4	3	several patches with paler outer zone, covering up to 40% leaf area
5	4	long streaks covering up to 75% leaf area or breaking of leaves / stalks from the center
6	5	complete drying of the leaves/ stalks or breaking of the leaves / stalks from the base

Data were collected on leaf infection and percent leaf area diseased and calculated in terms of disease incidence and disease severity (PDI) by following formulae-

2.1 Disease Incidence (DI)

$$DI (\%) = \frac{\text{no.of infected leaf}}{\text{Total no.of inspected leaf}} \times 100\%$$

2.2 Percent Disease Index (PDI) or Percent Disease Severity

$$PDI = \frac{\text{Total sum of numerical ratings}}{\text{Number of observation} \times \text{Maximum disease rating in the scale}} \times 100\%$$

2.3 Percent Disease Control (PDC)

$$PDC (\%) = \frac{PDI \text{ in Control} - PDI \text{ in treatment}}{PDI \text{ in Control}} \times 100\%$$

2.4 Area under Diseased progress Curves (AUDPC)

Area under Disease Progress Curves (AUDPC) was calculated using the formula given by Das et al. (1992)

$$AUDPC = \sum_{i=1}^{n-1} \left[\frac{Y_i + Y_{i+1}}{2} \right] \times (t_{i+1} - t_i)$$

Where, Y_i=disease severity on the ith date

$$Y_{(i+1)} = \text{disease severity on the } i+1\text{th date}$$

n = number of dates

3. RESULT AND DISCUSSION

3.1 Effects of fungicides on biometric parameters of onion

There was both significant and insignificant relationship found between applied fungicides and biometric parameters of onion. The applied fungicides showed insignificant differences with umbel diameter and number of umbel per hill while significant differences was seen in plant height, thousand seed weight and yield. The highest plant height was recorded from Hexaconazole (130.8cm) treated plot at par with Mancozeb+ Cymoxanil and Dimethomorph. Likewise, the maximum thousand seed weight was obtained from Hexaconazole (3.727gm) sprayed plot followed by Mancozeb + Cymoxanil and Tebuconazole. Similarly, maximum yield was seen in Hexaconazole (878.7kg/ha) sprayed plot which was found statistically similar with Mancozeb + Cymoxanil (878.3kg/ha).

The above finding collaborated with the result of the different other researchers around the world. Some researchers found out the positive and significant impact of fungicides on plant height and also observed statistically significant variation in terms of umbel diameter for the effectiveness of different chemicals and environmentally friendly components against purple blotch of onion (Haque, 2015). Similarly, Islam et al. 2013, had also shown remarkable influence of different treatments on height of onion seed stalk (cm) (Islam and Faruq, 2006). Likewise, Ahmed, 2018 had shown insignificant relationship between number of umbel/hill and applied fungicides against purple blotch of onion (Ahmed et al., 2018).

Treatment	Biometric Parameters				
	Plant Height (cm)	Umbel diameter (cm)	No. of umbel/hill	Thousand seed Weight (gm)	Yield (kg/ha)
Control	106.1 c	3.70	2.467	2.523 ^d	458.5 ^e
Carbendazim	122.0 ab	4.24	2.952	3.007 c	692.4 c
Tebuconazole	125.2 ^{ab}	4.58	2.962	3.533 ^{ab}	839.3 ^{ab}
Hexaconazole	130.8 ^a	4.87	3.467	3.727 a	878.7 ^a
Chlorothalonil	123.9 ^{ab}	4.46	3.086	3.423 b	773.7 ^b
Dimethomorph	130.7 a	5.03	3.152	3.433 b	847.6 ^{ab}
Mancozeb + Cymoxanil	129.0 a	5.01	3.333	3.643 ^{ab}	878.3 ^a
Trichoderma	117.8 b	4.50	3.048	2.927 c	573.1 ^d
SEm (±)	2.643	0.320	0.2187	0.0731	25.54
LSD (=0.05)	8.017	NS	NS	0.2217	77.47
CV%	3.7	12.2	12.4	3.9	6.0
Grand mean	123.20	4.55	3.058	3.277	742.7
P value	<.001***	0.140	0.153	<.001***	<.001***

Note: SEm_{pm}, Standard Error of mean; CV, Coefficient of variation; LSD, Least significant difference. Means in the column with the same letter (s) in superscript indicate no significant difference between treatments at 0.05 level of significance. *** Significant at 0.001 level of Significance

3.2 Effects of fungicides on disease parameters

Disease incidence percentage was significantly influenced by the application of the different fungicides against purple blotch complex. The data on disease incidence of onion varies throughout the observation period. At 145 DAP the lowest disease incidence (31.11%) was recorded from Hexaconazole treated plot which is followed by Mancozeb+Cymoxanil plot. The highest disease incidence (87.78%) was seen from control plot which was found statistically similar with

Trichoderma treated plot. Similarly, at 175 DAP the reduction on the disease incidence was highest on the Mancozeb+Cymoxanil treated plot with DI% of (43.33%). In case of 205 DAP, Mancozeb+ cymoxanil fungicide was found to be more effective against Purple blotch complex with disease incidence percentage of (21.1%).

Purple blotch complex was suppressed significantly due to the application of different fungicides on the field condition. Data on Percent Disease Intensity of onion by fungus was influenced by different fungicides. It was calculated based on a rating scale 0-5 and found out the significant relationship between applied fungicides and percent disease intensity. At 145 DAP, the lowest PDI (21.3%) was obtained from Hexaconazole treated plot which was statistically similar with Mancozeb + Cymoxanil treated plot. Likewise, the highest PDI was recorded from untreated control plot. At 175 DAP, Hexaconazole treated plot showed the lowest disease severity of purple blotch (25.33%) which was found statistically similar with Dimethomorph (26.67%), Mancozeb+ Cymoxanil (28.00%) and Tebuconazole (29.33%). Again, at 205 DAP Hexaconazole (9.33%) was found to be more effective in controlling disease severity at par with Mancozeb + Cymoxanil (12.00%).

A group researchers tested different fungicides and found 100% inhibition in Hexaconazole followed by Difenaconazole (83.91%) and Mancozeb (63.58%) (Wanggikar et al., 2014). Some researchers also examined different concentrations of systemic fungicides in vitro and revealed that Hexaconazole was found most effective with highest mean inhibition of radial growth (98.21%) followed by Propiconazole (97.32%) and Difenaconazole (91.23%) against the purple blotch complex of onion (Yadav et al., 2017).

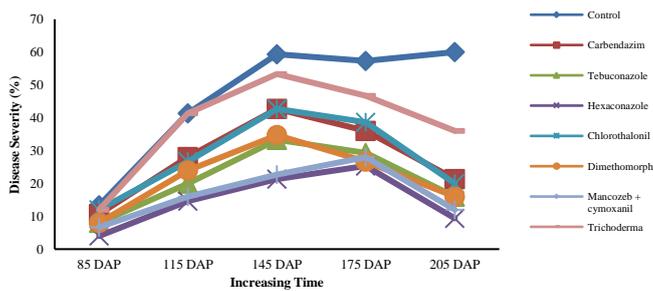


Figure 1: Percentage disease severity of purple blotch complex of onion with respect to different treatment at different dates of observation

Table 4: Influence of different fungicides on disease parameters in red creole variety of onion at different dates of observation at Chaurjahari Municipality, Rukum-West, Nepal, 2019

Treatments	Disease Incidence (%)			Disease Severity (%)		
	145 DAP	175 DAP	205 DAP	145 DAP	175 DAP	205 DAP
Control	69.84 ^a (87.78)	89.94 ^a (100.00)	89.99 ^a (100.0)	7.713 ^a (59.3)	7.604 ^a (57.33)	7.778 ^a (60.00)
Carbendazim	50.12 ^b (58.89)	61.24 ^c (76.68)	44.36 ^c (48.9)	6.564 ^{bc} (42.7)	6.024 ^c (36.00)	4.654 ^c (21.33)
Tebuconazole	37.90 ^{cd} (37.78)	43.06 ^f (46.67)	33.81 ^{de} (31.1)	5.801 ^c (33.3)	5.443 ^d (29.33)	4.062 ^d (16.00)
Hexaconazole	33.85 ^d (31.11)	43.70 ^{ef} (47.78)	29.46 ^{ef} (24.4)	4.654 ^d (21.3)	5.079 ^d (25.33)	3.122 ^e (9.33)
Chlorothalonil	41.12 ^c (43.34)	56.07 ^d (68.89)	38.51 ^{cd} (38.9)	6.569 ^{bc} (42.7)	6.245 ^c (38.67)	4.528 ^{cd} (20.00)
Dimethomorph	39.87 ^c (41.12)	47.52 ^e (54.45)	35.19 ^{de} (33.3)	5.928 ^c (34.7)	5.200 ^d (26.67)	4.062 ^d (16.00)
Mancozeb + Cymoxanil	36.57 ^{cd} (35.56)	41.14 ^f (43.33)	26.84 ^f (21.1)	4.809 ^d (22.7)	5.339 ^d (28.00)	3.536 ^e (12.00)
Trichoderma	65.20 ^a (82.23)	78.19 ^b (95.76)	52.10 ^b (62.2)	7.304 ^{ab} (53.3)	6.850 ^b (46.67)	6.024 ^b (36.00)
SEm (±)	1.607	1.357	2.163	0.2612	0.1888	0.1555
LSD (=0.05)	4.874	4.116	6.560	0.7921	0.5728	0.4715
CV%	5.9	4.1	8.6	7.3	5.5	5.7
Grand mean	46.81	57.61	43.78	6.168	5.973	4.721
P value	<.001* **	<.001* **	<.001* **	<.001* **	<.001* **	<.001* **

Note: SEm\pm, Standard Error of mean; CV, Coefficient of variation; LSD, Least significant difference; Means in the column with the same letter (s) in superscript indicate no significant difference between treatments at 0.05 level of significance; ‘***’ Significant at 0.001 level of Significance; ‘**’ Significant at 0.01 level of Significance; ‘*’ Significant at 0.05 level of Significance. Value in the Parenthesis indicate mean value while without parenthesis indicate Arcsine transformed value (ASIN (SQRT(X/100))×180/(22/7)) and Square root transformed value (SQRT(X+0.5))

3.3 Economic analysis of different fungicides

The benefit cost ratio was analyzed to figure out the most economic method of purple blotch complex management under farmer field condition. It was calculated using the formulae:

$$B:C = \frac{\text{Total income from onion seed production}}{\text{Total Expenditure for onion seed production}}$$

Hexaconazole was found to be most economic among all the tested fungicides with highest B:C ratio of 3.02 and the lowest AUDPC value of 2240. It was found statistically similar with Mancozeb + Cymoxanil and Tebuconazole with B:C ratio of 2.92 and 2.8 respectively. This result is supported by the result, that Cymoxanil 8% + Mancozeb 64% WP may be used as a better choice in managing the disease and also to overcome resistance development in the pathogen (Rao et al., 2014). However, Treatments in this research varies, the result can be correlated.

Table 5: AUDPC and B:C ratio calculation of different fungicides in red creole variety of onion at different dates of observation at Chaurjahari Municipality, Rukum-West, Nepal, 2019

Treatment	Total AUDPC	B:C ratio
Control	6800 ^e	1.187 ^d
Carbendazim	3990 ^c	2.320 ^b
Tebuconazole	3030 ^b	2.807 ^a
Hexaconazole	2240 ^a	3.020 ^a
Chlorothalonil	3980 ^c	2.683 ^{ab}
Dimethomorph	3140 ^b	2.683 ^{ab}
Mancozeb + Cymoxanil	2320 ^a	2.920 ^a
Trichoderma	5410 ^d	1.673 ^c
SEM (±)	190.5	0.1302
LSD(=0.05)	577.8	0.3950
CV%	8.5	9.4
Grand mean	3864	2.412
P value	<.001***	<.001***

Note: SEm\pm, Standard Error of mean; CV, Coefficient of variation; LSD, Least significant difference. Means in the column with the same letter (s) in superscript indicate no significant difference between treatments at 0.05 level of significance; ‘***’ Significant at 0.001 level of Significance.

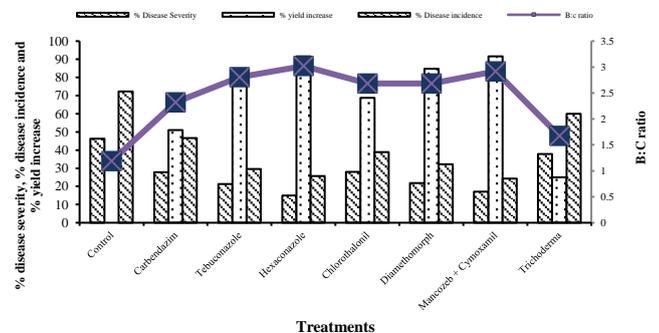


Figure 1: Economic analysis of different treatment along with disease incidence and disease severity

3.4 Relationship between disease severity and weather condition

The multiple liner regression equation was fitted to the data and the equation arrived for the weather parameters was:

$$Y = -137.65 * X_1 + 1.13 X_2 + 5.41 X_3 - 4.43 X_4 + 1.41 X_5$$

Where, Y= Percentage Disease Index (PDI)

X_1 = Precipitation (mm/day)

X_2 = Relative humidity at 2m (%)

X_3 = T_{max} at 2m (°C)

X_4 = T_{min} at 2m (°C)

X_5 = Long wave radiation flux (MJ/m²/day)

In year 2019, the coefficient of multiple determinants (R^2) was 0.7858 indicating 78.58% of variation in purple blotch development explained by the set of variable in the study. When there was increase in one unit of Relative humidity (1%), maximum temperature (1°C) and longwave radiation flux (MJ/m²/day), the Percent diseased index increased by 1.13, 5.41 and 1.41 units respectively. While when there was increase in one unit of precipitation (mm/day) and minimum temperature (°C), the Percentage disease index decreased by 1.17 and 4.43 units respectively.

4. CONCLUSION

The study inferred the best effective fungicides that can be easily adopted by the farmers to control purple blotch havoc in their field. Influence of treatment on biometric characters like plant height, number of umbel stalk, and umbel diameter at different dates of observation was found statistically significant as well as insignificant. But the influence of the treatments on the disease parameters was found highly significant in each dates of observation. Hexaconazole gave the maximum yield (878.7 kg/ha) which was found statistically correspondent with Mancozeb + Cymoxanil. Likewise, same fungicides Hexaconazole scored maximum thousand seed weight (3.727 gm). Regarding the disease incidence and disease severity, Hexaconazole and Mancozeb+Cymoxanil performed better with lowest total AUDPC value of 2240 and 2320 respectively. The Percentage disease control at 205 DAP was found highest (84.45%) in Hexaconazole treated plot followed by Mancozeb+Cymoxanil treated plot. The economic analysis of tested fungicides was done where Hexaconazole was proved to most efficacious with B:C ratio of 3.02. Similarly, the study of weather parameter in relationship to disease occurrence was done and found out that the minimum temperature, maximum as well as minimum relative humidity proved to be congenial for disease development. On the basis of the present finding it is concluded that Hexaconazole @ 0.1% concentration is the best remedy to control the purple blotch complex of onion.

RECOMMENDATION

Most effective measure to control the Purple blotch complex is use of the resistant cultivars and good cultural management practices against the disease, but in case of their unavailability, then only solution of the farmers is to use the chemical fungicides for the management of purple blotch complex. Hence it is recommended to use Hexaconazole @ 0.1% concentration among all other fungicides for the control and management of purple blotch complex in the study site.

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AUTHOR CONTRIBUTIONS

Nisha Paneru conducted the experiment and recorded data, analyzed and created the final manuscript. Pragya Adhikari, Puja Tandan and Sushil Chandra Sapkota helped during data observation and manuscript preparation.

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