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Crop Loss Assessment of Onion Due to Attack of Purple Blotch Complex

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Abstract

Purple blotch complex caused by *Alternaria porri* and *Stemphylium vesicarium* is a major disease of onion in Bangladesh causing severe yield loss. Field experiments were conducted at the central experimental farm of Sher-e-Bangla Agricultural University, Dhaka during three crop seasons of 2011-12, 2012-13, and 2013-14 to assess crop loss due to the disease through regression analysis. To create different levels of severity of purple blotch complex and loss of onion, an effective fungicide, Score 250 EC (Difenoconazole) was applied as foliar spray for 0-8 times at 10 days interval. The fungicide effectively controlled purple blotch and loss in bulb as well as seed yield. Higher yield loss was corroborated with higher disease severity. The relationship between yield loss of bulb and disease severity was expressed by the regression equiation $Y = 3.973+0.952x$. By asigning any x's value of PDI in the equation, the yield loss of onion bulb could be estimated. The seed yield loss was directly correlated with the PDI on flower stalk. Their relationship might be explained by the regression equation, $Y = 0.6529x + 6.5829$. By setting any x's value (PDI) in the equation, the yield loss of onion (Y) due to purple blotch complex could be estimated. Results of the investigation clearly show that foliar spray with Score 250 EC at 0.1% for 1-7 times with 10 days interval considerably reduced severity of purple blotch complex and increased bulb and seed yield of onion.

Keywords: *Alternaria porri*, Crop loss assessment, Purple blotch complex, *Stemphylium vesicarium*

1. Introduction

Purple blotch complex caused by *Alternaria porri* and *Stemphylium vesicarium*is a major disease of onion throughout the world including Bangladesh (Islam *et al.*, 2001; Mohsin *et al.*, 2016). Production of onion especially seed yield are severely affected by the disease. It causes 35% to 100% loss in seed and bulb production (Tyagi *et al.*, 1990).

Onion is used as important and popular vegetables in Australia, Belgium, India, Japan, United Kingdom, USA and many other countries including Bangladesh. Bangladeshis the 8^{th} largest onion producer country in the world (FAO, 2018). The production of onion in Bangladesh is 1866000 metric tons and second in area 186000 hectares against its demand of 2200000 tones among the spices crop in Bangladesh (BBS, 2018). This is particularly important for Bangladesh because existing mean yield of onion is very low (8.69 t ha^{-1}) as compared to the world average of 18.33 t ha^{-1} (FAOSTAT, 2015). The low yield and production might be due to attack of many diseases including purple blotch complex, use of low quality seeds, imbalanced fertilizers and improper irrigation.

Initially, the purple blotch complex is characterized by small water-soaked lesions on leaves and seed stalk. As the lesions enlarge, they become zonate, brown to purple, surrounded by a purple margin and extend upward and downward to some extent. Under humid condition, the surface of the lesion may be covered with brown to dark gray structure of fungus. A few large lesions are formed in a leaf or seed stalk which may coalesce and girdle the leaf or seed stalks. Usually the affected leaves or seed stalks break down and die within 4 weeks if the environment favors the disease and proper management methods are not applied (Gupta *et al.*, 1986). Islam (1995) and Islam *et al*. (2001) evaluated seven fungicides against *Alternaria porri* causing purple blotch of onion. Score (Difenconazole) was found as the most effective fungicide followed by Rovral (Iprodione), Tilt 250 EC (Propiconazole) and Folicur (Tebuconazole). Percentage of reduction in disease index varied from 48.34 to 65.44 in score, 45.48 to 64.02 in Rovral, 34.90 to 47.24 in Tilt 250 EC and 32.93 to 46.34 in Folicur. Fungicidal treatments increased bulb yield by 10.53% to 95.53% over unsprayed control. Sultana *et al*. (2008) conducted an experiment to assess yield loss of onion bulb due to purple blotch disease and found that 71.95% diseases reduce in the fungicide spraying plot over control. Yield bulb increased by 10.6-50.9% in fungicide sprayed plot over control.

Application of an effect fungicide may control purple blotch complex and increase crop yield. Generally, disease severity and yield loss due to a disease are negatively correlated with dosage and number of spray, which create variation in disease severity and yield reduction. Creating such variations, the relationship between disease severity and yield loss can be determined through regression analysis. Considering the above facts the present study was undertaken to simulate the mathematical point model for yield loss assessment of onion due to purple blotch complex.

2. Materials and Methods

2.1 Treatment

To create different levels of incidence and severity of purple blotch complex of onion, an effective fungicide, Score 250 EC (Difenoconazole) were applied as foliar spray in the main field at 0.10% aqueous suspension for 0-8 times starting from 25 days after transplanting (DAP) of seedlings with 10 days interval. Every time, freshly prepared fungicide suspension in tap water was sprayed. At the time of spray, individual experimental plot was encircled with polyethylene sheet to protect the nearby plots from drifting of fungicide suspension.

2.2 Experimental site and period

Two independent field experiments were conducted to estimate yield loss of onion bulb and seeds in the experimental farm of Sher-e-Bangla Agricultural University (SAU) Dhaka, Bangladesh during three consecutive onion growing seasons of 2011-12, 2012-13 and 2013-14. The soil of the experimental site belongs to the agro-ecological zone of 'Madhupur Tract' (AEZ-28). The top soil is silty clay loam in texture having 0.82% organic matter and pH 5.47-5.63. The monthly average, maximum and minimum temperature, relative humidity, total rainfall, and sunshine hours were obtained from Bangladesh Meteorological Department, Agargaon, Dhaka.

2.3 Land preparation and fertilization

The experimental field soil was opened with a power tiller drawn rotovator and exposed to the sun for 10 days. Large soil clods were broken into small pieces with a wooden hammer. Subsequently, cross ploughing followed by laddering was done to level the field and to have good tilth. At the time of final land preparation well decomposed cow dung at 10t/ha and recommended doses of chemical fertilizers such as Urea, triple supper phosphate (TSP), muriatic of potash (MoP), sulfur (Zypsum), Zinc (ZnO) and Boron (Boric power) were applied ((BARC, 1997). After final preparation, the experimental field was divided into unit plot following randomized complete block design with four replications.

The unit plot size was 6 m^2, plot to distance was length wise 1.0 m and breadth wise 0.5 m and block to block distance was 1.0 m. Raised bed was made by digging soil from the spaces around unit plots and leveled properly. Entire amount of TSP, MoP, ZnO, Zypsum and Boric power and one-fourth of Urea were applied at final land preparation. The rest amount of Urea was applied in three equal installments at 40, 60 and 80 DAP.

2.4 Growing of onion

Twenty five days old onion seedlings of variety 'Tahepuri' were procured from Gourango bazaar, Manikgonj. Before transplanting, 10-12 cm of top from top and 2 cm of roots from the base were trimmed off. Seedlings were transplanted in unit plots maintaining 15 cm plant to plant and 30 cm row to row distances. An insecticide, Ektara was prayed against thrips and other insect pests. Irrigation, gap filling weeding, mulching and other necessary intercultural operations were done as and when required.

2.5 Collection and analysis of data

Data on percent leaf area diseased (LAD) was recorded at 25 to 95 days after transplanting at 10 days interval by visual observation of visible symptoms. Percent leaf area diseasedwas calculated every time using the following formula (Aktari, 2013):

$$\% \text{ LAD} = \frac{\text{Diseased leaf or stalk area}}{\text{Total leaf or stalk area}} \times 100$$

Disease severity was indexed on a scale a 0-5 scale, where 0=leaf/stalk/free from purple blotch complex, 1=0.10-5.0, 2=5.1-12.0, 3= 12.1-25.0, 4= 25.1-50.0 and 5 = >50.0% leaf/stalk area diseased (Aktari, 2013).

Percent disease index (PDI) was computed using the following a standard formula (Aktari, 2013):

$$\text{PDI} = \frac{\text{Sum of all disease ratings}}{\text{Total number observations} \times \text{Maximum grade in scale}} \times 100$$

Every year, onion bulbs were harvested in April when plants showed sign of leaf drying. To avoid injuries to bulbs, proper care was taken. Leaves were cut at 2 cm above the bulb, dried in the sun and bulb weight per plot was recorded. For seed collected, umbels were harvest at ripening stage and sundried. Seeds were separated from umbel, dried in the sun and seed weight per plot was recorded. The yield of bulb and seed was expressed in t/ha and kg/ha, respectively.

The severity of purple blotch complex and yield loss of bulb and seed were recorded during onion seasons of 2011-12, 2012-13 and 2013-14. Polled data of three consecutive years on those parameters were subjected to statistical analysis for ANOVA using a software, Statistix 10. Treatment means were compared using Least Significance Difference (LSD) Test (P=0.05). Predicted yield loss was estimated by regression analysis. Regression line was drawn considering polled value of PDI at 95 DAP as independent variable and yield as dependent variable using a computer software, EXCEL.

Regression analysis is a statistical technique that can test the hypothesis that a variable is dependent upon one or more other variables. The general linear regression model can be stated by the equation: Y=a+bx, where Y=predicted value, a= intercept, b= coefficient of regression and x= independent variable. The coefficient of determination (R^2) is a measure that assesses the ability of a model to predict or explain an outcome in the linear regression setting. More specifically, R^2 indicates the proportion of the variance in the dependent variable (Y) that is predicted or explained by linear regression and the predictor variable (X, also known as the independent variable. The correlation of coefficient value (r) indicates the closeness of two variables. In the present experiment, regression analysis was performed to predict decrease in disease severity and increase in yield loss due to application of fungicide against purple blotch of onion.

3. Results and Discussion

3.1 Purple blotch severity (PDI) on leaf of bulb crop at 25 - 95 days after transplanting (DAP)

Polled data (average of 2011-12, 2012-13, 2013-14) on PDI of purple blotch complex on onion leaf recorded at 25 to 95 DAP at 10 days interval is summarized in Table 1. It was found that onion leaves were free from infection with the disease under 0 – 8, 1- 8, 2 - 8, 3 - 8, 4 - 8, 5 - 8, 6 - 8 and 7 - 8 times of spray with Score 250 EC at 25, 35, 45, 55, 65, 75, 85 and 95 DAP, respectively. The PDI was 6.19 at 0 spray, 8.28 - 20.92 at 0 - 1, 8.50 - 25.03 at 0 - 2, 9.25 - 32.63 at 0 - 3, 10.25 - 40.02 at 0 - 4, 10.78 - 58.26 at 0 - 5 and 11.39 - 83.33 at 0 - 6 times sprays recorded at 35, 45, 55, 65, 75, 85 and 95 DAP, respectively. The differences in PDI at individual day of data collection during 35-95 DAP under different treatments were significant (P=0.05).

3.2 Disease severity (PDI) on leaf at 95 DAP and bulb yield

The effect of different treatments (spray number) on disease severity (PDI) on leaf of onion bulb crop at 95 DAP are summarized in Table 2.The PDI (average three consecutive seasons) were 84.33, 63.33, 55.33, 43.23, 34.64, 20.03, 11.39 and 0.00 under 0, 1, 2, 3, 4, 5, 6 and 7 times sprays of fungicides. The differences in PDI under various treatments were significant. Application of fungicide reduced the PDI by 24.87, 34.38, 48.73, 58.92, 76.24, 86.49 and 100.00% over control under 1, 2, 3, 4, 5, 6 and 7 times spray, respectively. The PDI was decreased gradually with the increase of spray number. The higher reduction was corroborated with higher number of spray (Table 2).

Bulb yield was 2.40, 3.85, 5.02, 6.20, 7.60, 8.40, 10.30 and 11.80 t/ha under the treatments of 0, 1, 2, 3, 4, 5, 6 and 7 times spray, respectively. Higher yield was corroborated with higher number of spray. The loss in bulb yield was 79.66, 67.37, 57.46, 47.46, 35.60, 28.81, 12.71 and 0.0 0% over control under PDI of 84.33, 63.33, 55.33, 43.23, 34.64, 20.03, 11.39 and 0.00 recorded at0, 1, 2, 3, 4, 5, 6 and 7 times spray, respectively. Higher loss in yield was corroborated with higher PDI. Yield loss was not caused under 7 or higher number of spray (Table 2).

3.3 Relationship of PDI with spray number at 95 DAP on leaf and bulb yield

The relationship between spray number and PDI could be explained by the regression equation Y=79.229 – 11.483x, where Y= predicted PDI value, x = number of spray, 79.229 is the intercept and -11.258 is the coefficient of regression. The coefficient of regression indicates that one unit increase in spray number causes 11.483 unit decrease in PDI. The coefficient of coefficient between number of spray and PDI was negative but highly significant (r = -0.995**). The coefficient of determination (R^2) was 0.990 (Fig. 1).

Relationship between spray number and bulb yield could be explained by the regression equation Y=2.38 + 1.3046x, where Y=predicted value of bulb yield, where x= number of spray, 2.38 is intercept and 1.30 is the coefficient of regression. The coefficient of regression indicates that one unit increase in spray number causes 1.30t/haincreases in bulb yield. The coefficient of correlation was positive andhighly significant (r = -0.995**). The coefficient of determination (R^2) was 0.997 (Fig. 2).

Relationship of loss in bulb yield with disease severity (PDI) of purple blotch complex of onion as influence by fungicidal spray may be expressed by the regression equation, Y = 3.973+0.952x, where Y=predicted yield at a specific level of PDI (x), coefficient of regression is0.952 and intercept is3.973. The predicted yield loss ($\hat{Y}$) could becomputed using the above regression equation.By setting any x value (PDI) in the equation, the yield loss of onion due to purple blotch complex disease could be estimated. The correlation coefficient was r = 0.991**, which indicates relationship between PDI and bulb yield loss was positive and highly significant. The coefficient of determination is $R^2 = 0.982$, which show that the influence of PDI on yield loss is 98.22% (Fig. 3).

3.4 Purple blotch severity (PDI) on flower stalk of onion seed crop during 25 - 95 days DAP

The effect of different treatments (spray number) on PDI of onion flower stalk at different DAP and yield at different levels of spray are shown in Table 3. Incidence of purple blotch complex on flower stalk did not appear at 25 and 35 DAP under 0-8 times, at 45 DAP under 1-8 times, at 55 DAP under 3-8 times, at 65 DAP under 4-8, at 75 DAP under 5-8 times and at 85 DAP under 6-8 times fungicidal sprays. The PDI varied 9.47-19.45, 9.53-36.90, 12.99-61.22, 11,74-89.33 and 2.85-93.99 at 55, 65, 75, 85 and 95 DAP under 0-3, 0-4, 0-5 and 0-7 times sprays, respectively. Most of the cases, the variations in PDI at different times of spay was significant (P=0.05). The PDI was 7.32, 19.45, 36.90, 61.22, 89.33 and 93.99% at 45, 55, 65, 75, 85 and 95 DAP, respectively.

Table 1. Polled PDI value (average three crop seasons of 2011-12, 2012-13 and 2013-14) of purple blotch complex of onion leaf recorded at 25 to 95 DAP at 10 days interval as affected by foliar spray with 0.10% suspension of Score 250 EC

Treatment (Number of spray)	Percent Disease Index (PDI) on leaf at 25 to 95 DAP (polled data of three consecutive years)							
	25	35	45	55	65	75	85	95
0	0.00	6.19a	20.92a	25.03a*	32.63a	40.02a	58.26a	84.33a
1	0.00	0.00b	8.28b	19.17b	25.15b	33.63b	43.98b	63.35b
2	0.00	0.00b	0.00c	8.50c	18.25c	29.70c	41.13c	55.33c
3	0.00	0.00b	0.00c	0.00d	9.25d	19.37d	28.98d	43.23d
4	0.00	0.00b	0.00c	0.00d	0.00e	10.27e	21.12e	34.64e
5	0.00	0.00b	0.00c	0.00d	0.00e	0.00f	10.78f	20.03f
6	0.00	0.00b	0.00c	0.00d	0.00e	0.00f	0.00g	11.39g
7	0.00	0.00b	0.00c	0.00d	0.00e	0.00f	0.00g	0.00h
8	0.00	0.00b	0.00c	0.00d	0.00e	0.00f	0.00g	0.00h

*Figures within the same column with a common letter(s) do not differ significantly (P=0.05).

Table 2. Polled data (average of three consecutive years) on severity of purple blotch (PDI) on leaf and bulb yield of onion recorded at 95 days of transplanting (DAP) under different number of foliar sprays with 0.1% suspension of Score 50 EC.

Treatment (Number of spray)	PDI on leaf at 95 DAP	% Reduction in PDI[a]	Bulb yield (t/ha)	% Loss in bulb yield[b]
0	84.33a*	-	2.40h	79.66
1	63.35b	24.87	3.85f	67.37
2	55.33c	34.38	5.02e	57.46
3	43.23d	48.73	6.20d	47.46
4	34.64e	58.92	7.60bcd	35.60
5	20.03f	76.24	8.40bc	28.81
6	11.39g	86.49	10.30b	12.71
7	0.00h	100.00	11.80a	0.0
8	0.00h	100.00	11.83a	0.00

*Figures within the same column with a common letter(s) do not differ significantly (P=0.05).
[a] Percentage of reduction in PDI was calculated based on PDI under control.
[b]Percentage of yield reduction was calculated based on yield 7 times spray where highest yield was obtained.

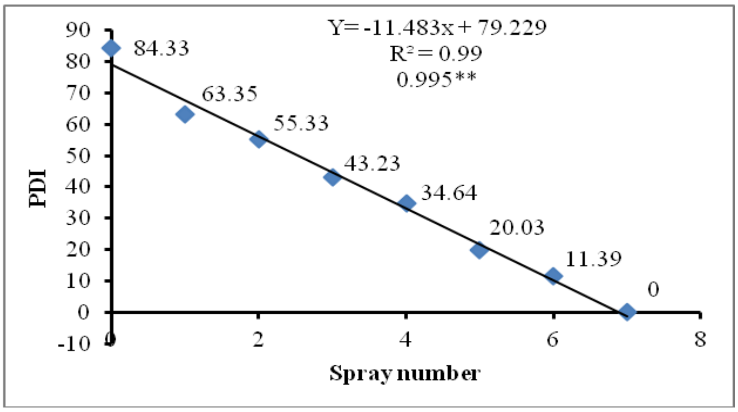

Fig. 1. Relationship of PDI with number of spray of Score 250 EC at 0.10% against purple blotch complex on leaf of onion bulb crop

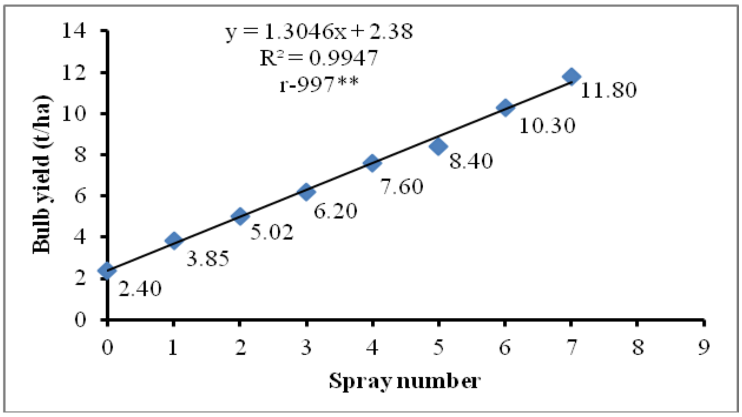

Fig.2. Relationship between number of spray with Score 250 EC at 0.10% against purple blotch on leaf and bulb yield of onion

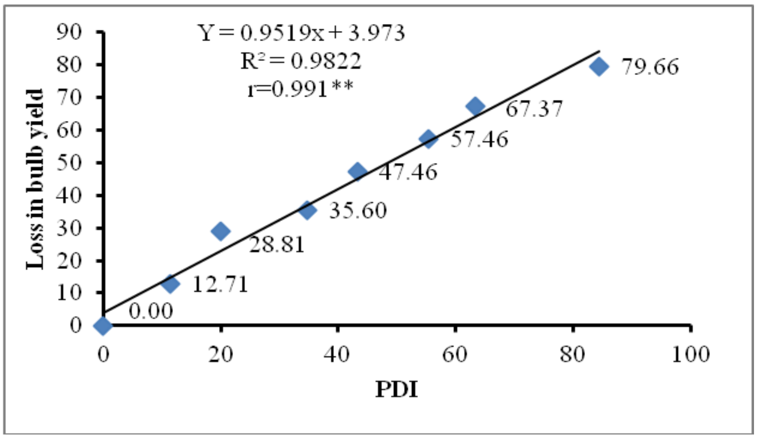

Fig. 3. Relationship of loss in bulb yield with severity (PDI) of purple blotch complex of onion as influenced by fungicidal spray

Severity (PDI) of purple blotch complex on flower stalk at 95 DAP ranged 0.00 – 93.99 under 0-8 times spray of fungicides. Purple blotch did not appear on flower stalk at 8 times sprays. The maximum PDI was recorded from control. The PDI was reduced by 3.59-100.00% due to application fungicides for 1-8 times. Reduction in PDI increased with the increase of spray number (Table 4).

Seed yield varied 146.52 – 521.82 kg/ha at 0 – 8 times spray. The variations in seed yield under different treatments were significant. The maximum yield was obtained at 8 spraysof Score 250 EC (0.1%) followed by 7, 6, 5 and 4 sprays and the lowest from control followed by 1, 2 and followed by 1, 2 and 3 times spray. In general, higher yield was corroborated with higher number of spray. The loss in seed yield ranged 7.02 – 71.92% under 0.00 – 93.99 PDI recorded from 1-7 times spray. Lower loss in seed yield was corroborated with lower number of spray. The highest yield reduction was recorded from higher PDI value (Table 4).

Table 3. Polled PDI (average of 2011-12, 2012-13 and 2013-14) of purple blotch complex on flower stalk of onion seed crop recorded at 25 to 95 DAP at 10 days interval as affected by foliar spray with 0.10% suspension of Scroe 250 EC

Treatment (Number of spray)	Percent Disease Index (PDI) on flower stalk at 25 to 95 DAP (Average of three consecutive years)							
	25	35	45	55	65	75	85	95
0	0.00	0.00	7.32a	19.45a*	36.90a	61.22a	89.33a	93.99a
1	0.00	0.00	0.00b	14.28ab	27.69ab	45.77b	81.15b	90.62b
2	0.00	0.00	0.00b	9.47c	23.91b	40.89b	66.44c	77.92c
3	0.00	0.00	0.00b	0.00d	9.53c	25.64c	44.69d	65.13d
4	0.00	0.00	0.00b	0.00d	0.00d	12.99d	28.48e	47.27e
5	0.00	0.00	0.00b	0.00d	0.00d	0.00e	11.74f	35.21f
6	0.00	0.00	0.00b	0.00d	0.00d	0.00e	0.00g	13.29g
7	0.00	0.00	0.00b	0.00d	0.00d	0.00e	0.00g	2.85h
8	0.00	0.00	0.00b	0.00d	0.00d	0.00e	0.00g	0.00i

*Figures within the same column with a common letter(s) do not differ significant

Table 4. Polled data on severity of purple blotch (PDI) on flower stalk at 95 DAP and seed yield of onion under different number of foliar sprays with 0.1% suspension of Score 50 EC.

Treatment (Number of spray)	PDI on leaf at 95 DAP	% Reduction in PDI[a]	Seed yield (kg/ha)	% Loss in seed yield[b]
0	93.99a*	-	146.52e	71.92
1	89.62b	3.59	192.87de	63.04
2	77.92c	17.10	250.17cd	52.06
3	65.13d	30.71	286.31c	45.15
4	47.27e	49.71	302.65bc	42.00
5	35.21f	62.54	335.52bc	35.70
6	13.29g	85.86	417.20b	20.04
7	2.85h	96.97	485.16a	7.02
8	0.00	100.00	521.82a	-

*Figures within the same column with a common letter(s) do not differ significantly (P=0.05).

[a] Percentage of reduction in PDI was calculated based on PDI under control.

[b] Percentage of yield reduction was calculated based on yield at 8 times spray where seed yield was the maximum.

3.5 Relationship between PDI on flower stalk at 95 DAP and seed yield

In the present study, the PDI on flower stalk was negatively but significantly correlated with number of spray where the correlation coefficient (r) was -991**. Their relationship could be explained by the regression equation Y = 100.28-13.258x, where Y is the predicted value of PDI, x= number of spray (independent variable), 100.28 is intercept and -13.258 is the coefficient of regression. The coefficient of regression indicates that one unit increase in spray number causes 13.258 unit decrease in PDI. In the present study, the coefficient of determination (R^2) was 0.992, which indicates that influence of PDI may be explained by 98.17%. The predicted yield loss ($\hat{Y}$) may be calculated using the regression equation between PDI and PDI (Fig. 4).

The seed yield was directly and significantly correlated with number of spray of Score 250 EC at 0.10%, where the correlation coefficient (r) was 989**. Relationship of two variables could be explained by the regression equation Y = 142.38 + 46.022x,where Y is the predicted seed yield, x= number of spray independent variable), 142.38 is the intercept and 46.022 is the coefficient of regression. The coefficient of determination (R^2) is 0.9784, which indicates that influence of spray number on seed yield may be explained by 97.84%.The predicted seed yield ($\hat{Y}$) may be calculated using the regression equation between two variable (Fig. 5).

The seed yield loss was directly and significantly correlated (r=980**) with the PDI on flower stalk. The relationship between PDI on flower stalk and loss in seed yield may be explained by the regression equation, Y = 0.6529x + 6.5829, where Y= predicted yield loss, x= independent variable, 0.6529 is the coefficient of regression and 0.6529 is the intercept. The coefficient of determination (R^2 = 0.9599) of the present study indicates that influence of PDI on yield loss may be explained by 95.99%.By setting any x's value (PDI) in the equation, the yield loss of onion (Y) due to purple blotch complex could be estimated and these values show linear regression relationship (Fig. 6).

Foliar spray with Score 250 EC at 0.10% against purple blotch on leaf and flower stalk of onion effectively reduced the severity of the disease and increased the yield of bulb and seed. Higher increase in yield and decrease in disease severity were recorded under higher number of spray. The relationship between yield loss of bulb and severity was expressed by the regression equation Y = 3.973+0.952x. It was directly correlated with the PDI on flower stalk.

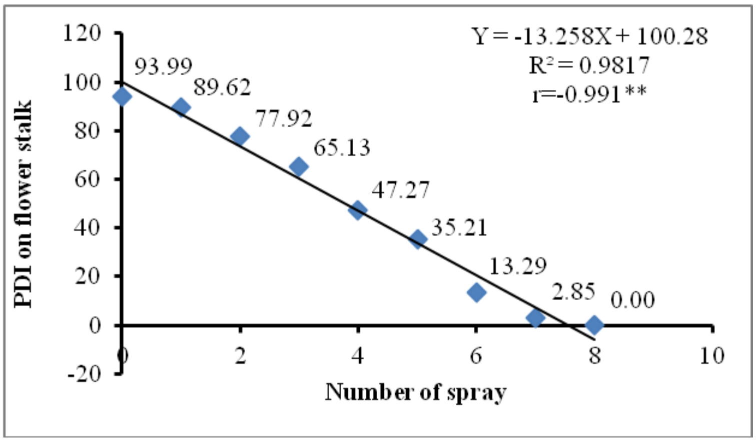

Fig. 4. Relationship of severity of purple blotch complex (PDI) on flower stalk of with number of spray with Score 250 EC spray at 0.10%

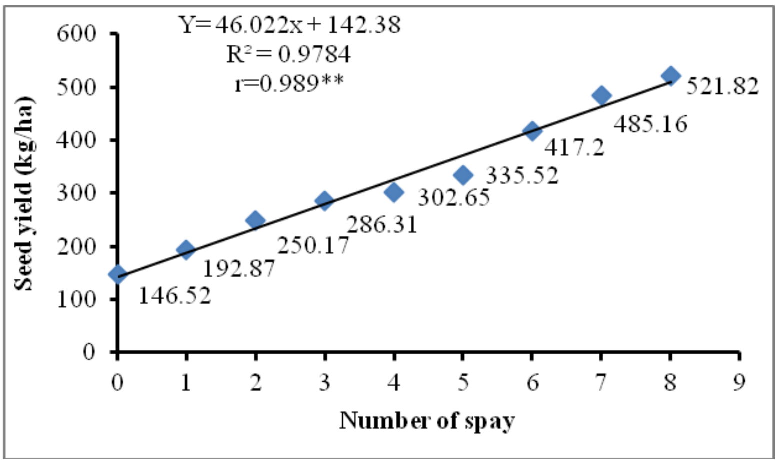

Fig. 5. Relationship of seed yield of onion with number of spray with Score 250 EC at 0.10%

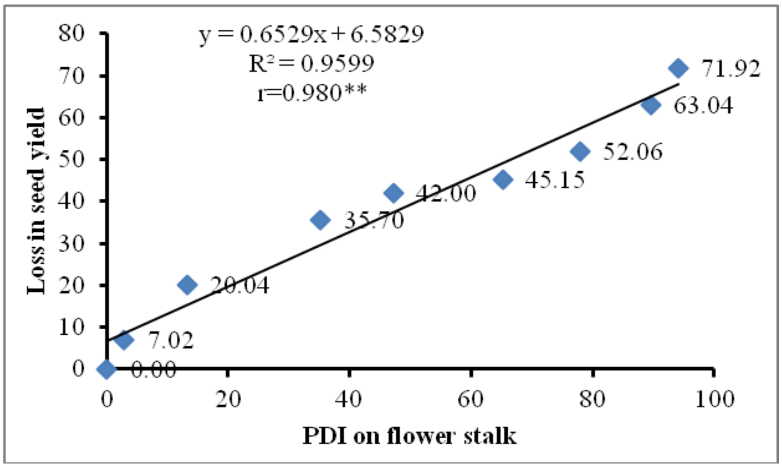

Fig. 6. Relationship of loss in seed yield of onion with PDI on flower stalk as affected by spray with Score 250 EC at 0.10% against purple blotch

Similarly, the relationship of seed yield loss might be explained by the regression equation, Y = 0.6529x + 6.5829. By setting any x's value (PDI) in the equation, the yield loss (Y) due to purple blotch complex could be estimated.Effectiveness of the Score 250 EC to control purple blotch of onion has been reported by many other researchers (Aujla etc., . 2020). The fungicide is also recommended by the Pesticide Copany Syngenta, Bangladesh. Islam (1995) and Islam et al. (2001) evaluated seven fungicides against *Alternaria porri* causing purple blotch of onion. Score (Difenconazole) was found as the most effective fungicide followed by Rovral (Iprodione), Tilt 250 EC (Propiconazole) and Folicur (Tebuconazole). Percentage of reduction in disease index varied from 48.34 to 65.44 in score, 45.48 to 64.02 in Rovral, 34.90 to 47.24 in Tilt 250 EC and 32.93 to 46.34 in Folicur. Fungicidal treatments increased bulb yield by 10.53% to 95.53% over unsprayed control. Sultana et al. (2008) conducted an experiment to assess yield loss of onion bulb due to purple blotch disease and found that 71.95% diseases reduce in the fungicide spraying plot over control. Yield bulb increased by 10.6-50.9% in fungicide sprayed plot over control.

4. Conclusions

Based on findings of the present investigation, it may be conclude that foliar spray with an effective fungicide, Score 250 EC at 0.1% suspension for 7times with 10 days interval considerably reduced severity of purple blotch complex of onion and increased bulb and seed yield.

5. Acknowledgments

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