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Field Experiment to Evaluate the Efficacy of Different Doses of Chemical Fungicides against Rice Brown Leaf Spot Disease Caused by *Bipolaris Oryzae L.* at Paklihawa, Rupandehi, Nepal

Sunil Shrestha[1,*], Laxman Aryal[2], Binaya Parajuli[1], Jharana Panthi[1], Pratibha Sharma[1], Yogendra Singh Saud[1]

[1]Institute of Agricultiure and Animal Science, Paklihawa Campus, Nepal
[2]Grain Legumes Research Program, Khajura, Banke, Nepal
*Corresponding author: shresthasunil672@gmail.com

Abstract Brown Leaf Spot of Rice, caused by the Pathogen *Bipolaris oryzae*, is one of the important rice diseases resulting in high yield reduction and poor grain quality. A field experiment was conducted to evaluate the efficacy of different doses of chemical fungicides against brown leaf spot in 'SabhaMansuli' variety of rice in the research field of Institute of Agriculture and Animal Sciences, Paklihawa Campus from July 15, 2015 to December 1, 2015. The experimental design was RCBD with three replications and ten treatments. Treatments comprised of three different chemical fungicides; SAAF® (Carbendazim 12% + Mancozeb 63%), Tilt® (Propiconazole 25 EC) & Bavistin® (Carbendazim 50% W.P.) at three different doses of 1.5, 2 & 2.5 g (or ml) and a control plot. Among the different fungicides, Tilt® at the rate of 2 ml/lit water showed significantly lowest AUDPC value (373.7) followed by SAAF® at 2 gm/lit (374.9) while the highest value was shown by Bavistin® at 2gm/lit (590.1).Similarly, highest economic yield was obtained in SAAF® at 2gm/lit (5.220 t/h) followed by Tilt® at 2ml/lit water (5.210t/ha) and the lowest in Bavistin® at 1.5gm/lit (3.320t/ha). So, among different chemical fungicides, SAAF® at 2gm/lit being efficient, economical and easily accessible, farmers could be suggested for reducing the disease severity and subsequent increase in the yield of rice.

Keywords: *SAAF®, Tilt®, Bavistin®, brown leaf spot, Sabha Mansuli variety of rice*

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1. Introduction

Rice is most preferred staple food crop of Nepal and fulfills about 50% of the total calorie requirement of people. In Nepal the total area covered by rice production is 1,486,951 hectare with annual production of 5,047,047 tons and productivity of 3.39 t/ha [8]. The terai region contains 68.32% of the total rice area and contributes to 70.84% of total rice production with productivity of 3.51 t/ha. whereas hills and mountains have 27.53% and 4.14% of total rice area producing 26.19% and 2.97% of rice production with productivity of 3.22 and 2.42 t/ha [8]. Being the important staple food crop of Nepal, it has got great significance regarding the livelihood of farmers.

The brown leaf spot disease of rice is one of the most devastating diseases of rice that caused Bengal Famine in 1942 with the yield loss of 50-90% which resulted in the death of about 2 million people due to starvation [9].Among the fungal diseases, brown leaf spot of rice caused by pathogen *Bipolari soryzae* is a major disease occurring in almost all the rice growing areas of the world causing 5% yield loss across all lowland rice production situations in South and Southeast Asia [11]. The pathogen infects the coleoptiles and causes blighting, and turns the leaves oval in shape with dark brown to purplish-brown spots that rigorously damage photosynthetic activity ultimately killing the leaf [4].

The optimum temperature favorable for growth, conidial production and spore germination of brown spot has been found to be around 20°C with relative humidity above 80% [2,5]. The excess of the nitrogen fertilizer aggravates the disease severity. The disease becomes more severe under stress conditions, causes seed discoloration, reduces seedling vigor, impairs grain quality and results in yield loss. There are different methods for the management of disease as use of resistant varieties, Cultural, Biological and Chemical methods .But the application of the fungicides is the most effective management option for the control of brown spot of rice [6]. The use of fungicides, such as iprodione, propiconazole, azoxystrobin, trifloxystrobin, and carbendazim are effective in disease management [7].

As there are available different fungicides in the market and also due to limited research on the management practices, farmers are in dilemma of using which fungicides at what doses. Therefore, our experiment wants to find out the efficacy of different fungicides at different doses so that better management practices could be suggested to the farmers for the better control of the disease with increment in yield.

2. Materials and Methods

The experiment was conducted in the research field of Agronomy farm at Institute of Agriculture and Animal Science (IAAS), Paklihawa Campus, Rupandehi, Nepal from 15th July 2015 to 1st December 2015 (139 days). Experiment site is situated 1km North from the campus premises at 270 30' 0" North, 830 27' 0" East with an elevation of 109m.

2.1. Treatments

The treatments comprised of 3 different fungicides in 3 different doses and a control/check plot to test the efficacy of common fungicides and find out their effective dose in brown spot management.

Table 1. Different treatments with notations

Trade name	Generic name	Dose	Notations
Bavistin®	Carbendazim 50% W.P.	1.5 g/L	T1
		2 g/L	T2
		2.5 g/L	T3
Tilt®	Propiconazole 25 EC	1.5 mL/L	T4
		2 mL/L	T5
		2.5 mL/L	T6
SAAF®	Mancozeb 63% + Carbendazim 12% W.P.	1.5 g/L	T7
		2 g/L	T8
		2.5 g/L	T9

2.2. Experimental Design

The experimental design used in this research was Complete Randomized Block Design (RCBD) with 10 treatments and 3 replications. Ten treatments were randomly distributed in each replication with inter-block spacing of 1m and inter-plot spacing of 50 cm within a block. Total net cultivated area was 30m^2. Size of an individual plot was 1m^2. Both row to row and plant to plant spacing were 20 cm such that 5 plants were maintained in each row and 25 plants in each plot.

2.3. Cultivation Practices

Rice variety named as Sabha Mansuli, a long duration variety, was selected for the experiment. Seedlings were collected from the seed bed of local farmer. Rice was grown in submerged or puddle condition. One month prior to transplanting, the bunds were constructed around the main field. At about 15 days prior to transplanting the field was flooded 2-3 times with water and ploughed 2-3 times by cultivator followed by planking one day prior to the transplanting. Rice seedlings were transplanted in each 1m2 plots at the spacing of 20cm*20cm with 2-3 seedlings per hill. The half doses of Nitrogen (N) and full doses of Phosphorus (P) and Potassium (K) with the recommended doses of 120:60:40 NPK/ha were applied during transplanting. Remaining half doses of N was later top dressed. Regular irrigation and timely weeding and hoeing were done.

First incidence of disease was recorded in the field on September 6, 2015. However, the disease scoring was started after the disease severity was visible in the field when observed from a distance. 10 sample tillers per each plot in each replication were selected in cross fashion as double diagonal form of a square and tagged in order to identify the tillers for disease evaluation. Scoring was done with the help of scale for measuring the disease intensity at 7 am in the morning.

Scoring scale of brown spot disease under field condition was rated according to the International Rice Research Institute (IRRI) scale of 1-9 (0= No lesions; 1= small brown speaks of pin point size or large brown speaks without speculating center; 2= small round disc to slightly elongated necrotic grey spots of 1-2 mm in diameter with distinct brown margin lesions are mostly found on lower leaves; 3= lesion type are same as in scale 2 but significant number of lesions are on upper leaves; 4= typical susceptible blast lesion, 3mm or longer infection lesions on 2% of leaf area; 5= typical blast lesion infecting 2-10% of leaf area; 6= typical blast lesion infecting 11-25% of leaf area; 7= typical blast lesion infecting 26-50% of leaf area; 8= typical blast lesion infection 51-75% of leaf area; 9= more than 75% leaf area affected) [1]. Disease scoring was done 5 times, by the visual estimation on the sample plants of each plot with reference to the IRRI scale of disease severity, at 6 days intervals from 90 days after transplanting (DAT) to 114 DAT.

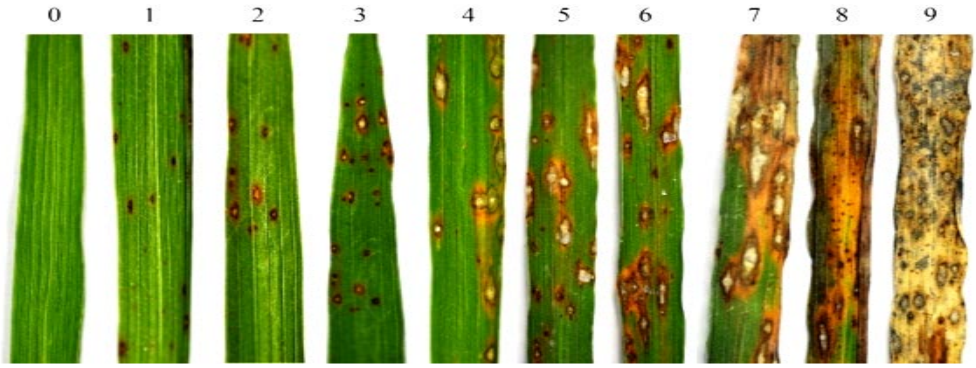

Figure 1. Scale for the scoring of brown leaf spot of Rice given by IRRI, 2009

Except last scoring, each scoring was followed by foliar spray of different fungicides (Bavistin®, Tilt® and SAAF®) on the same day at noon as per the respective treatments; with the help of Knapsack Sprayer fitted with hollow cone nozzle.

2.5. Disease Intensity

Data were taken at 6 days interval to calculate disease severity and area under disease progress curve (AUDPC) by using following formula and scale.

$$\text{Disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plant assessed}} \text{x100.}$$

The severity of disease was examined visually on tagged plants along the plot and recorded as the percentage of plant parts (tissues) affected (percentage of blast infection on plant).

$$\text{Percent severity index}\left(\text{PSI}\right) = \frac{\text{Sum of numerical rating}}{\text{No. of plants rated x max. score of scale}} \text{x100.}$$

2.6. Estimation of AUDPC

The area under disease progress curve (AUDPC) was calculated by summarizing the progress of disease severity. The pattern of epidemic in terms of number of lesions, amount of diseased tissue, or number of diseased plants is given by a curve, called the disease progress curve, that shows the epidemic over time, and the area covered by this curve is known as AUDPC. AUDPC value was calculated by using the following formula as given by Das [3].

$$\text{AUDPC} = \sum_{\text{i}=1}^{n} (Y_{i+1} + Y_i) 0.5 (T_{i+1} - T_i)$$

Where, Y_i = disease severity on the i^{th} date,

t_i= time on which Y_i was recorded and

n = number of times observations were taken.

2.7. Harvest Index

Harvest index is the ratio of economic yield and biological yield in percentage. It was calculated by using following formula:

$$\textit{Harvest Index} = \frac{\text{Economical yield}\left(\text{grain yield}\right) kg / ha}{\text{Biological yield}\left(\text{grain yield}\right) kg / ha} \text{x100.}$$

2.8. Plant Parameters Studied

The plant parameters such as plant height (cm), number of filled grains/panicle, total number of grains/panicle, number of chaffy grains/panicle, weight of grains/panicle, test weight and yield of grains (t/ha) were recorded. All data were analyzed for evaluating test of significance.

2.9. Statistical Analysis

Data entry and processing was carried using Microsoft Excel 2010 and all the recorded data were analyzed using MSTAT-C software. The means were compared and analyzed by Duncan's Multiple Range Test (DMRT).

2.10. Meteorological Statistics

The meteorological data such as mean, maximum and minimum temperature and rainfall were recorded from the nearby meteorological station at National Wheat Research Program, Rupandehi, Nepal. The temperatures and precipitation recorded during the period are shown in the Figure 2 below. The data shows that maximum temperature recorded was 35.1°C during September and minimum temperature was 16°C during the month of November. The maximum rainfall recorded was 250.8 mm in July and minimum of 28.9 mm in October.

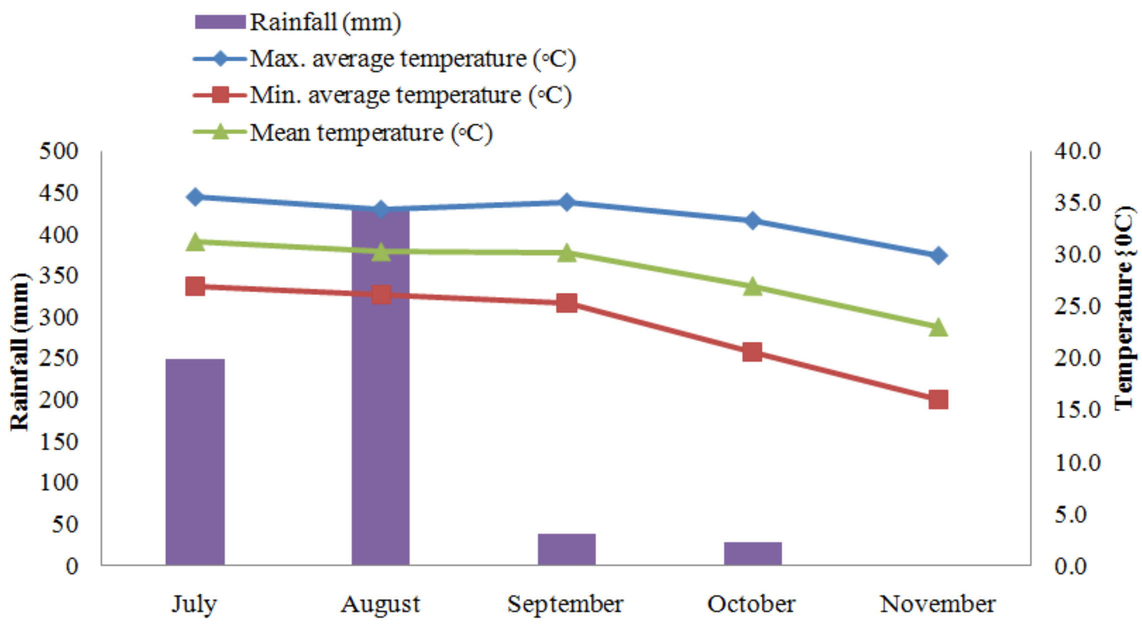

Figure 2. Meteorological condition of the field during the experiment period (July- December, 2015)

3. Results and Discussion

3.1. Disease Assessment

3.1.1. Area under Disease Progressive Curve (AUDPC)

Area under disease progressive curve (AUDPC) was calculated based on disease intensity recorded in 90 DAT, 96 DAT, 102 DAT, 108 DAT and 114 DAT. The treatments varied significantly in AUDPC values. Among the different fungicides with different dosesTilt® (Propiconazole) at the rate of 2mL/Lhad the lowest and Bavistin® at the rate of 2g/L had the highest AUDPC value with the mean value of 373.7 and 590.1 respectively. Sunder *et al.* [12] found the reduction in disease severity from 22.34%-5.19% with the use of Tilt® at the rate of 2mL/Land the best option for management.

3.1.2. AUDPC Value and Economic Yield

There was significant difference among AUDPC values and Economic Yield. The fungicide SAAF® at the rate of 2g/Lhas the mean AUDPC value 374.9 and highest economic yield 5.220 t/ha while Bavistin®at rate of 1.5g/Lhas the AUDPC value 521.6 and lowest economic yield 3.320 t/ha. (Table 2)

3.2. Disease Severity

Disease severity values for brown spot were found insignificant during first second and third scoring taken at 90 DAT, 96 DAT and 102 DAT respectively. But fourth and fifth scoring has significant values of disease severity taken at 108 DAT and 114 DAT respectively. It was due to the reason as fungicides require some time duration (about 5-7 days) to show effect. (Table 3)

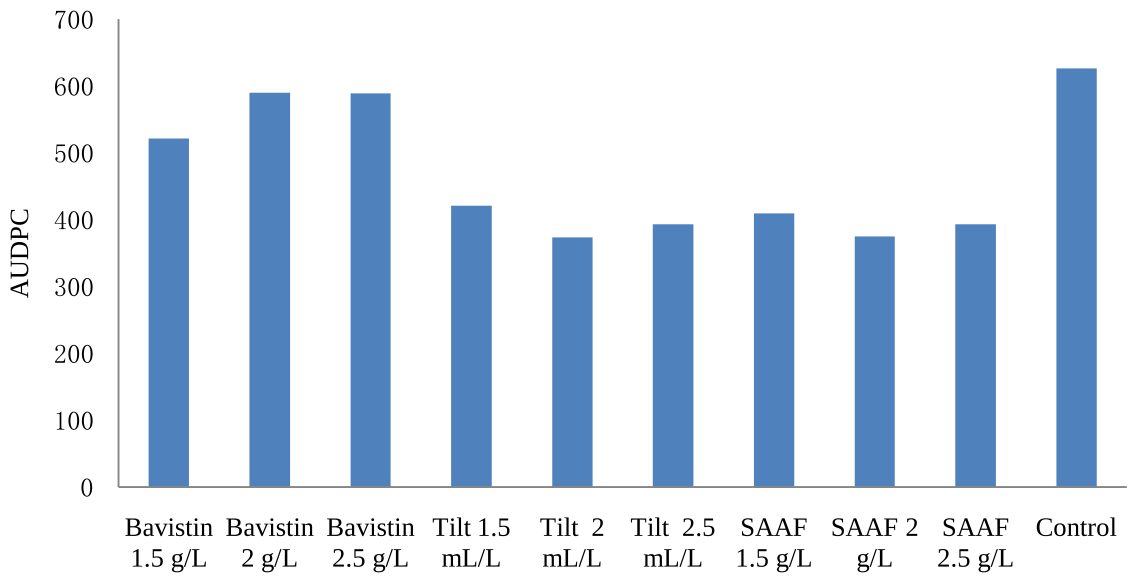

Figure 3. Mean AUDPC value with use of 3 fungicides at 3 different doses during July- December, 2015 at Paklihawa, Rupandehi, Nepal

Table 2. Mean AUDPC value and economical yield of rice treated with different doses of different fungicides in field during July- December, 2015 at Paklihawa, Rupandehi, Nepal

Treatments	AUDPC value	Economic yield (t/ha)
Bavistin® 1.5 g/L	521.6^{ab}	3.320^{e}
Bavistin® 2 g/L	590.1^{a}	3.553^{d}
Bavistin® 2.5 g/L	588.8^{a}	3.530^{d}
Tilt® 1.5 mL/L	420.9^{bc}	4.917^{b}
Tilt® 2 mL/L	373.7^{c}	5.210^{a}
Tilt® 2.5 mL/L	393.0^{bc}	4.673^{c}
SAAF® 1.5 g/L	409.2^{bc}	5.127^{a}
SAAF® 2 g/L	374.9^{c}	5.220^{a}
SAAF® 2.5 g/L	393.1^{bc}	4.913^{b}
Control	626.1^{a}	3.527^{d}
Probability	0.0015*	0.0000**
CV%	16.39	1.42
sEM±	5913.653	0.004
LSD	123.6	0.1085

(t/ha): ton per hectare, CV: Coefficient of variation, sEM (±): Standard error of mean, LSD: Least significant difference; means followed by the same letter in a column are not significantly different by DMRT at 5% level of significance.

Table 3. Mean disease severity value of rice at different DAT treated with different doses of different fungicides in field during July- December, 2015 at Paklihawa, Rupandehi, Nepal

Treatments	90 DAT	96 DAT	102 DAT	108 DAT	114 DAT
Bavistin® 1.5 g/L	12.81^{a}	19.33^{ab}	18.33^{a}	28.48^{b}	28.74^{a}
Bavistin® 2g/L	14.19^{a}	18.56^{ab}	27.41^{a}	29.04^{b}	32.52^{a}
Bavistin® 2.5 g/L	14.56^{a}	16.48^{ab}	22.37^{a}	35.07^{a}	33.85^{a}
Tilt® 1.5 mL/L	14.3^{a}	17.78^{ab}	25.37^{a}	14.15^{de}	11.41^{b}
Tilt® 2 mL/L	13.19^{a}	16.63^{ab}	20.22^{a}	13.81^{de}	10.04^{b}
Tilt® 2.5 mL/L	14.04^{a}	17.26^{ab}	22.44^{a}	12.7^{e}	12.15^{b}
SAAF® 1.5 g/L	12.59^{a}	17^{ab}	19.96^{a}	19^{c}	11.89^{b}
SAAF® 2 g/L	12.44^{a}	12.85^{b}	21.52^{a}	16.93^{cd}	9.926^{b}
SAAF® 2.5 g/L	13.81^{a}	14.74^{ab}	19.04^{a}	19^{c}	11.67^{b}
Control	14.81^{a}	22.67^{a}	26.04^{a}	28.67^{b}	39.16^{a}
Probability	-	0.4118	0.3683	0.0000**	0.0003**
CV%	13.78%	25.10%	39.67%	9.73%	38.69%
sEM±	3.552	18.924	78.066	4.45	60.675
LSD	3.233	7.462	15.16	3.619	13.36

(t/ha): ton per hectare, CV: Coefficient of variation, sEM (±): Standard error of mean, LSD: Least significant difference; means followed by the same letter in a column are not significantly different by DMRT at 5% level of significance.

Table 4. Mean test weight and economical yield of rice treated with different doses of different fungicides in field during July- December, 2015 at Paklihawa, Rupandehi, Nepal

Treatments	Test weight	Economical yield (t/ha)
Bavistin® 1.5g/L	11.18^{ef}	3.320^{e}
Bavistin® 2g/L	11.27^{e}	3.553^{d}
Bavistin® 2.5g/L	11.37^{e}	3.530^{d}
Tilt® 1.5 mL/L	12.21^{c}	4.917^{b}
Tilt® 2 mL/L	12.92^{a}	5.210^{a}
Tilt® 2.5 mL/L	11.88^{d}	4.673^{c}
SAAF® 1.5g/L	12.68^{b}	5.127^{a}
SAAF® 2g/L	12.95^{a}	5.220^{a}
SAAF® 2.5g/L	11.95^{d}	4.913^{b}
Control	10.98^{f}	3.527^{d}
Probability	0.0000**	0.0000**
CV%	0.88	1.42
sEM±	0.011	0.004
LSD	0.1799	0.1085

(t/ha): ton per hectare, SEm (±): Standard error, CV: Coefficient of variation, LSD: Least significant difference means followed by the same letter in a column are not significantly different by DMRT at 5% level of significance.

3.3. Test Weight and Economic Analysis

From the result of disease assessment, it was found that the fungicide Tilt® at the rate of 2mL/L, showed the lowest mean AUDPC value (373.7) followed by SAAF® at the rate of 2g/L with mean AUDPC value (374.9). However highest grain yield was obtained from SAAF® at 2g/L (5.220 t/ha) followed by Tilt® at 2mL/L (5.21 t/ha). So, Tilt® at the rate of 2mL/L and SAAF® at the rate of 2g/L appeared as the efficient ones against brown leaf spot among all tested doses of fungicides in the field. Thus, the fungicide SAAF® at 2g/L was the efficient among 3 different doses of 3 different fungicides to brown leaf spot and produced highest grain yield in Paklihawa, Bhairahawa condition than other doses of fungicides. (Table 4)

3.4. Correlation and Regression Analysis

Simple linear regression analyses of selected parameters were performed.

There was significant negative relationship between the mean AUDPC and grain yield. According to the coefficient of determination, about 86.65% variation in yield on plant was due to the mean AUDPC and remaining portion due to other factors. According to the linear regression equation, it can be said that if there is a unit increase in mean AUDPC value, economic yield decreased by 0.0074 times. (Figure 4)

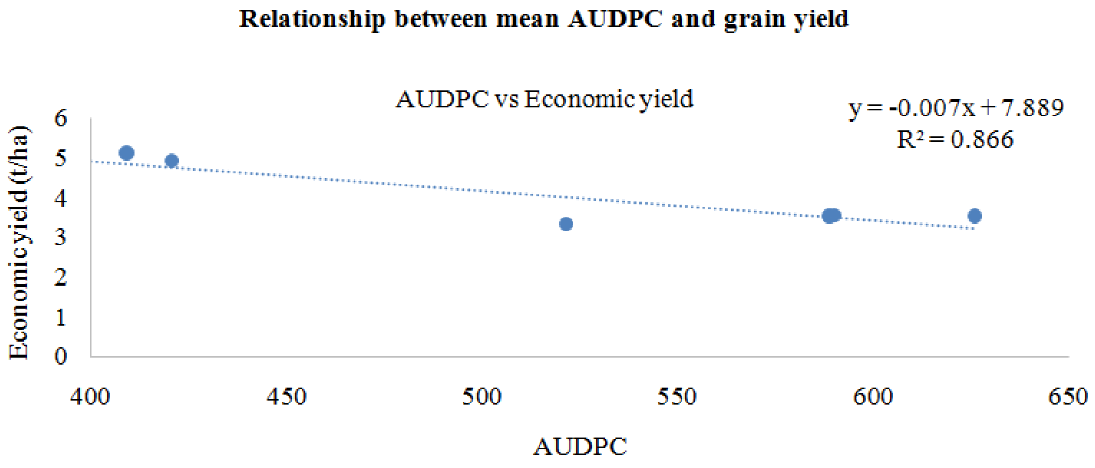

Figure 4. Estimated linear relationship between mean AUDPC and Yield in different doses of different fungicides during July- December, 2015 at Paklihawa, Rupandehi, Nepal

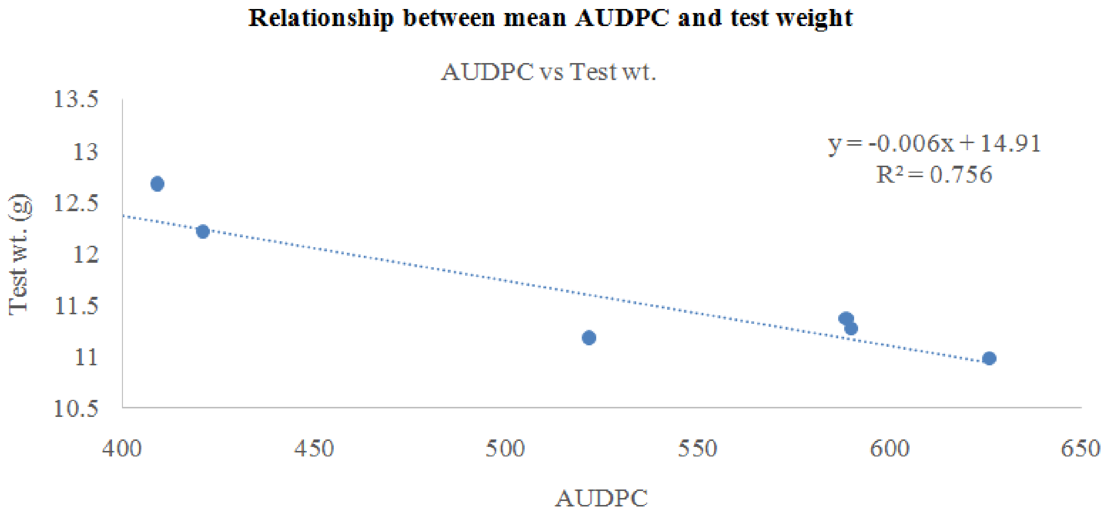

Figure 5. Estimated linear relationship between mean AUDPC and test weight in different doses of different fungicides during July- December, 2015 at Paklihawa, Rupandehi, Nepal

There was significant negative relationship between the mean AUDPC and test weight. According to the coefficient of determination, about75.65% variation in test weight was due to the mean AUDPC and remaining portion due to other factors. According to the linear regression equation, it can be said that if there is a unit increase in mean AUDPC value, test weight decreased by 0.0063 times. (Figure 5).

4. Summary & Conclusion

4.1. Summary

The AUDPC values of 10 treatments were calculated and found to differ significantly. Lowest mean AUDPC value was found to be of Tilt® at the rate of 2 ml/lit water (373.7) followed by SAAF® at 2g/L (374.9). While, the highest mean AUDPC value was found in control condition (626.1) followed by Bavistin®at 2g/L (590.1) and Bavistin® at 2.5 g/L (588.8). On the basis of mean AUDPC value 3 different fungicides with 3 different doses were categorized into 4 efficiency levels i.e. More efficient, Efficient, Less efficient and Inefficient. Among these treatments no any treatments were found to be more efficient. However, Tilt® at rate of 2mL/L, SAAF® at 2g/L, Tilt® at 2.5mL/L and SAAF® at 2.5g/Lwere found to be efficient while SAAF® at the rate of 1.5g/L, Tilt® at 1.5mL/L, Bavistin® at 1.5g/L, Bavistin® at 2.5g/L, Bavistin® at 2g/L were found to be less efficient.

Economic yield was found to be highest in SAAF® at the rate of 2g/L(5.220 t/ha), followed by Tilt® at 2mL/L (5.210 t/ha). Similarly, Test weight of rice was also found to be highest in SAAF® at 2g/L (19.95 gm) followed by Tilt® at 2mL/L (12.92gm).While the lowest economic yield and test weight were found in controlled condition (10.98gm). Among different doses of different fungicides Bavistin® at rate of 1.5 g/L had lowest test weight (11.92gm) and grain yield value (3.320 t/ha).

4.2. Conclusion

Brown leaf spot of Rice, being one of the most devastating diseases, highly affects the yield of crop. The application of different chemical fungicides showed different results in the economic yield. Among different doses of treatments Tilt® at the rate of 2ml/lit water and SAAF®at 2gm/lit water showed significant result for the efficient management of brown spot of rice with higher test weight and economic yield. As SAAF® being efficient, economical and easily accessible fungicides in the local market, it could be suggested to the farmers for the application of SAAF® at the doses of 2gm/lit of water at six days interval for effective control of brown leaf spot disease.

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