Estimation of Disease Intensity against *Cercospora* leaf spot of Okra (*Abelmoschus esculentus* L.) Moench through bio-control agents with chemical fungicides under Prayagraj Condition of India

. ABSTRACT

Okra (*Abelmoschus esculentus* L.) also known as bhendi is one of the most common vegetable preferred in every household of India . *Cercospora* leaf spot incited by *Cercospora abelmoschi*. is one of the emerging disease in Uttar Pradesh Region.. An experiment was conducted in Central Research Farm ,SHUATS , Prayagraj in Kharif season of 2022 to evaluate the efficacy of bioagents and chemicals *viz.,* T_0 – *Untreated control,* T_1 *Mancozeb (1%) + Trichoderma(4%)* , T_2 *- Mancozeb (1%) + Pseudomonas(4%)* , T_3 *Mancozeb (1%) + Bacillus subtilis(4%),* T_4 *- Mancozeb (1%) + Trichoderma(2%) + Pseudomonas(2%)* ,T_5 *- Mancozeb (1%) + Pseudomonas(2%) + Bacillus subtilis(2%),* T_6 *Mancozeb (1%) + Bacillus subtilis(2%) + Trichoderma(2%),* T_7 *- Mancozeb (1%)* against *Cercospora* leaf spot of okra. *C. abelmoschi* initiates with sooty black, angular spots and cause heavy defoliation Studies revealed that minimum disease intensity was observed in *T4 - Mancozeb (1%) + Trichoderma(2%) + Pseudomonas(2%)* and is hereby considered as the best treatment out of all the treatments.

Keywords: Mancozeb , Trichoderma , Pseudomonas, Bacillus.

1. INTRODUCTION

Okra *(Abelmoschus esculentus* L.) Moench is one of the most widely known species ofthe family Malvaceae and an economically important vegetable crop grown in tropical climate of temperature range between 25^0 to 35^0c. The name “Okra” derives from one of Niger-Congo group of languages. “Okra” originated in Ethiopia and was then propagated in North Africa, in the Mediterranean, in Arabia and India by the 12th century BC. “Okra” is known by many local names in different parts of the world. It is called lady’s finger in England, gumbo in the United States of America, guino-gombo in Spanish, guibeiro in Portuguese and bhindi in India.**(Gemede *et al.,* 2014).**

. Okra has nutritional as well as medicinal value. The okra pod is excellent source of iodine which is necessary for the resistant against throat disease like Goiter. It is good for the people suffering from heart weakness. Some studies are being developed targeting okra extract as remedy to manage diabetes. Its ripe seeds are roasted, ground and used as a substitute for coffee in some countries. Mature pods and stems containing crude fibre are used in the paper industry. Okra seeds are a potential source of oil, which consists of linoleic acid up to 47.4% and polyunsaturated fatty acid essential for human nutrition. **(Singh *et al.,* 2014).**

Okra contains Potassium, Sodium, Magnesium and Calcium as principal elements in pods, which contains 17% seeds. Presence of Iron, Zinc, Manganese and Nickel also has been reported (**Moyin-Jesu, 2007).**

Fresh pods are low in calories (20/100 g), practically no fat, richin fiber, and with several valuable nutrients. Okra seed is mainly composed of oligomeric catechins (2.5 mg g^{-1} of seeds), while the mesocarp is mainly composed of hydroxycinnamic (0.2 mg g^{-1}) and quercetin derivatives (0.3 mg g^{-1}). Pods are rich in phenolic compounds with important biological properties like quartering derivatives, catechin oligomers and hydroxycinnamic derivatives (**Arapitsas, 2008**).

Okra plant also contains many medicinal properties with it. But before using, it is very necessary to seek advice from a professional. The mucilage can be used as plasma replacement, helpful in washing away toxic substances from the body and have strongly demulcent action **(Gemede et al., 2015).**

Among the fungal diseases *Cercospora* leaf spot of bhendi incited by *Cercospora* is one of the most economically important in all regions wherever bhendi is grown. In India, two species of *Cercospora* produce leaf spots on bhendi. *C. malayensis* causes brown, irregular spots and *C. abelmoschi* causes sooty black,

angular spots. Both the leaf spots cause severe defoliation and are common during humid seasons. Now a days, this disease incited by *C. abelmoschi* becomes more severe in southern transition zone of Karnataka. Initially the disease symptoms observed on the lower surface of the leaves as in distinct spots in the form of olivaceous specks. Later on, light brown to grey mouldy growth of the fungus covered the entire lower surface. The infected leaves ultimately dry and defoliate. The disease progress upward from lower leaves and infects stem and fruits and produces similar symptoms. **(Naik *et al.*, 2017).**

2. MATERIAL AND METHODS

The experiment was conducted at the research plot of the Department of Plant Pathology and Central Research Field, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj during the *Kharif* season 2022. The selected site was uniform, cultivable with typical sandy loam soil having good drainage. The treatment was conducted in RBD Design with 7 treatment and control replicated thrice. The field plot was of 2*2m area .

Table 1. The treatment details.

S. No	Treatments	Treatment Details
1.	T0	Control
2.	T1	Mancozeb (1%) +*Trichoderma harzianum* (4%)
3.	T2	Mancozeb (1%) + *Pseudomonas fluorescens* (4%)
4.	T3	Mancozeb (1%) + *Bacillus subtilis*(4%)
5.	T4	Mancozeb (1%) + *Trichoderma harzianum* (2%) + *Pseudomonas fluorescens* (2%)

6.	T5	Mancozeb (1%) + *Pseudomonas fluorescens* (2%) + Bacillus subtilis(2%)
7.	T6	Mancozeb (1%) + *Bacillus subtilis*(2%) + *Trichoderma harzianum* (2%)
8.	T7	Mancozeb (1%)

Disease severity scale of *Cercospora* leaf spot

Disease intensity was recorded as grades in five randomly selected plants in each plot at different time that is before spraying, 15 days after the first spray and 15 days after the secondspray as per the scale of **Farrag (2011)** which is given below.

Table 2. Disease rating and description

Disease rating /grade	Description
0	**No disease**
1	**Noticeable spotting with some defoliation (< 25%)**
3	**Spotting heavy with significant defoliation (< 50%)**
5	**Very heavy leaf spotting with severe defoliation (< 75%)**
7	**Numerous spots on few remaining leaves and very heavy defoliation (< 90%)**
9	**Very few remaining leaves covered with spots and nearly complete defoliation (<95%)**

3.5 Disease intensity (%)

Percentage of Disease intensity will be recorded at 60,75 and 90 days after incidenceof *Cercospora* leaf spot. Percentage of Disease intensity will be calculated in accordance withfollowing formula. The disease will be visually assessed in all the plots at

weekly interval from first appearance of disease for each treatment. For each plot the number of infected okra plants will be counted and expressed as a percentage of the total number of okra plants in that plot. The mean percentage disease incidence for each treatment will be obtained from the three replications. The data will be further statistically analyzed.

Disease intensity (%) formula was given by **Wheeler (1969).** It is calculated by using the following formula:

$$\textbf{Disease intensity (\%)} = \frac{\textbf{Sum of all disease ratings}}{\textbf{Total no.of ratings X Maximum disease groups}} X100$$

Result and Discussion

Fig 1. Overview of Disease Infested Leaves

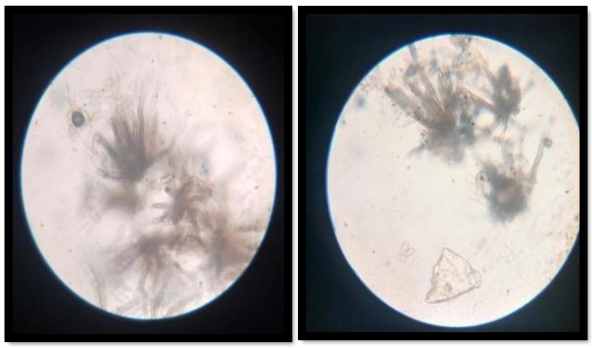

Fig 2: OVERVIEW OF MICROSCOPIC VIEW OF *Cercospora sp.*

Table 3: Effect of treatments on Disease Intensity of *Cercospora* leaf spot of okra at60,75 and 90 DAS

Tr.no	Treatment	DISEASE INTENSITY		
		60DAS	**75 DAS**	**90 DAS**
T0	**Control**	29.183[a]	36.290[a]	41.18[a]
T1	**Mancozeb (1%) +*Trichoderma harzianum* (4%)**	21.033[d]	27.403[e]	34.44[c]
T2	**Mancozeb (1%) + *Pseudomonas fluorescens* (4%)**	18.810[e]	25.920[f]	32.33[d]
T3	**Mancozeb (1%) + *Bacillus subtilis(4%)***	23.553[c]	30.810[c]	36.47[b]
T4	**Mancozeb (1%) + *Trichoderma harzianum* (2%) + *Pseudomonas fluorescens* (2%)**	14.367[g]	21.920[h]	26.66[f]
T5	**Mancozeb (1%) + *Pseudomonas fluorescens* (2%) + *Bacillus subtilis(2%)***	15.703[f]	23.847[g]	29.33[e]
T6	**Mancozeb (1%) + Bacillus subtilis(2%) + *Trichoderma***	23.847[c]	28.887[d]	34.51[c]

	***harzianum* (2%)**			
T7	**Mancozeb (1%)**	27.183[b]	33.480[b]	37.33[b]
C.D (5%)		1.009	1.044	1.867

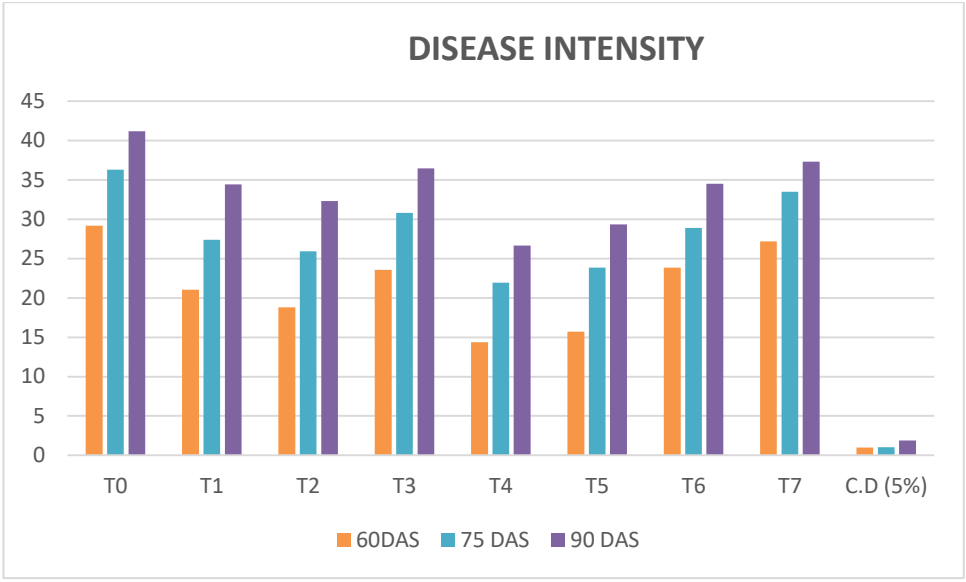

Fig 3. Disease Intensity

4.1 Disease Intensity:

4.1.1 Disease Intensity at 60 DAS

The data presented in table 3 and depicted in figure 3 reveals that maximum Disease intensity of okra at 60 DAS was recorded in T4 - Mancozeb (1%) + *Trichoderma(2%)* + *Pseudomonas(2%)* (14.36) followedby T5 - Mancozeb (1%) + *Pseudomonas(2%)* + *Bacillus subtilis(2%)* (15.70) and T2 - Mancozeb (1%) + *Pseudomonas(4%)* (18.81) followed by T_1 Mancozeb (1%) + *Trichoderma(4%)* (21.03) , T_6 Mancozeb (1%) + *Bacillus subtilis(2%)* + *Trichoderma(2%)*(23.553), T_3 Mancozeb (1%) + *Bacillus subtilis(4%)* (23.847) as compared to T7 - Mancozeb (1%) (27.18) and T0 – untreated control- (29.18). All the treatments were significant over untreated control. Among the treatments (T_7 and T_4) were statistically non significant to each other

4.1.2 Disease Intensity at 75 DAS

The data presented in table 3 and depicted in figure 3 reveals that maximum Disease Intensity of okra at 75 DAS was recorded in T4 - Mancozeb (1%)

+ *Trichoderma(2%)* + *Pseudomonas(2%)* (21.92) followedby T_5 - Mancozeb (1%) + *Pseudomonas(2%)* + *Bacillus subtilis(2%)* (23.84) and T_2 - Mancozeb (1%) + *Pseudomonas(4%)* (25.92) followed by T_1 Mancozeb (1%) + *Trichoderma(4%)* (27.40) , T_6 Mancozeb (1%) + *Bacillus subtilis(2%)* + *Trichoderma(2%)*(28.88), T_3 Mancozeb (1%) + *Bacillus subtilis(4%)* (30.81) as compared to T_7 - Mancozeb (1%) (33.48) and T0 – untreated control- (36.29). All the treatments were significant over untreated control.

4.1.3 Disease Intensity at 90 DAS

The data presented in table 3 and depicted in figure 3 reveals that maximum Disease Intensity of okra at 90 DAS was recorded in T_4 - Mancozeb (1%) + *Trichoderma(2%)* + *Pseudomonas(2%)* (26.66) followedby T_5 - Mancozeb (1%) + *Pseudomonas(2%)* + *Bacillus subtilis(2%)* (29.33) and T_2 - Mancozeb (1%) + *Pseudomonas(4%)* (32.33) followed by T_1 Mancozeb (1%) + *Trichoderma(4%)* (34.44) , T_6 Mancozeb (1%) + *Bacillus subtilis(2%)* + *Trichoderma(2%)*(34.51), T_3 Mancozeb (1%) + *Bacillus subtilis(4%)* (36.47) as compared to T_7 - Mancozeb (1%) (37.33) and T0 – untreated control- (41.18). All the treatments were significant over untreated control. Among the treatments (T_8 and T_4) , (T_7 and T_2) were statistically non significant to each other

Statistical analysis

The data obtained from the field experiment were statistically analyzed by following the standard procedures (**Panse and Sukhatme, 1989**). The percentage values were convertedto arcsine values wherever required.

Analysis of variance:

The analysis of variance was worked out to test the significance of F and t-tests. It was carriedout according to procedure of RBD analysis for each character. The total variance and degree of freedom were partitioned into three components *viz.,* replications, treatments and error. Analysis of variance was done under the fixed effect model given below: Let us suppose that there are 'k' treatments applied to 'r' number of replications. These can be represented by the symbols as follows:

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Conclusion:-

based on the observations it can be concluded that the efficacy of combining readily available and ecologically safe bioagents with synthetic safe mancozeb fungicide for the management of *Cercospora* leaf spot of okra .

From the critical analysis of the present findings, it can be concluded that after the application of all the treatments with three replications, T4 - Mancozeb (1%) + *Trichoderma(2%)* + *Pseudomonas(2%)* is the best treatment as it showed The **Disease Intensity of okra** at 60,75 and 90 DAS which was significantly increased by the use of Mancozeb (1%) + *Trichoderma(4%)* + *Pseudomonas(4%)* under Prayagraj Agro climatic conditions . Based on analysis T4 - Mancozeb (1%) + *Trichoderma(2%)* + *Pseudomonas(2%)* is recommended to control the *cercospora* leaf spot disease in Okra. The present findings were limited to one crop season *kharif* under the climatic conditions of Prayagraj , U.P. , therefore substantiate the present result more trails are required for further recommendations .

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DEFINITIONS, ACRONYMS, ABBREVIATIONS

Here is the Definitions section. This is an optional section.

Term: Definition for the term