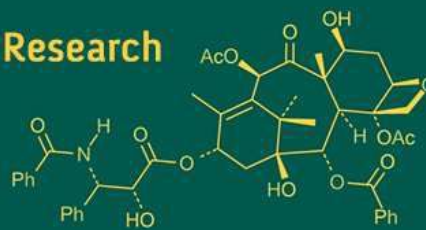


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Effect of botanical extracts against Southern leaf blight of maize (*Zea mays* L.) caused by *Bipolaris maydis* (Nisikado) Shoemaker

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Abstract

Maize (*Zea mays* L.) is an important cereal crop belonging to the grass family gramineae. Maize is known as king of cereals because of its high production potential and wide adaptability after rice and wheat, it contributes almost 9 percent of India's food basket. However, a considerable proportion of the maize crop is damaged each year due to diseases caused by various bacteria, fungi and viruses. Southern leaf blight is major disease of maize, which caused by ascomycetous fungus *Bipolaris maydis* (Drechs.) [synonym *Helminthosporium maydis* (Nisikado) Shoemaker] is common in tropical and subtropical region. Therefore, present study Effect of botanical extracts against Southern leaf blight of Maize (*Zea mays* L.) Caused by *Bipolaris maydis* (Nisikado) Shoemaker was carried out in kharif season in the year 2023 under field conditions.

Effect of treatments were evaluated on different growth and yield parameters of maize under field conditions. Maximum plant height @30 DAS (23.75 cm), @60 DAS (109.26cm) and @90 DAS (164.54cm) and maximum number of leaves @30 DAS (8), @60 DAS (14.73), @90 DAS (18.13) were recorded in treatment *Trichoderma viride* @5g/kg + NSKE @10%. *Trichoderma viride* @5g/kg + NSKE @10% was found effective against reducing the disease intensity (%) @45 DAS (10.03%), @60 DAS (15.35%) and @75 DAS (34.40%) followed by *Trichoderma viride* @5g/kg + Ginger rhizome extract @10% @45 DAS (13.15%), @60 DAS (19.14%), @75 DAS (37.43%) and maximum was found in *Trichoderma viride*@5g/kg + Garlic clove extract @10% @45 DAS (23.73%),@60 DAS (30.92%), @75 DAS (50.78%) as compared to control @45 DAS (25.17%), @60 DAS (33.44%) and @75 DAS (53.59%). The maximum yield was found to be in *Trichoderma viride* @ 5g/kg + NSKE @10% (4.4 t/ha) as compared to control (2.5 t/ha) and the maximum cost benefit ratio was also found to be in *Trichoderma viride* @ 5g/kg + NSKE @10% (1:28).

Keywords: *Bipolaris maydis*, botanical extract, Southern leaf blight, *Trichoderma viride*, *Zea mays*

1. Introduction

Maize (*Zea mays* L.) is known as king of Cereals because of its high production potential and wide adaptability (Falk, 2008) [1] and after rice and wheat, it is the most versatile crop adapted to different agro-ecological and climatic conditions. It is the third important cereal crop in India after wheat and rice and can be cultivated throughout the year. It is primarily used as feed (63.0%), food (23.0%), in starch industries (12.0%), seed, including miscellaneous uses (2.0%) in India (Malik *et al.*, 2018) [6]. The demand for starch is growing at 10–12% every year due to rising consumption in the food and pharma industry. It has greater calorific value and rich in amino acids with less toxins compared to grains like millet and broken rice (Kuilya *et al.*, 2018) [4].

Maize crop is damaged each year due to diseases caused by various bacteria, fungi and viruses. More than 115 diseases of maize have so far been reported from different parts of the world, whereas, about 65 are known to occur in India (Vanlalhruaia *et al.*, 2023) [14] inflicting about 9 per cent yield losses (Khokhar *et al.*, 2014) [3]. Turcicum leaf blight and Maydis leaf blight are two major diseases of maize, of which Turcicum leaf blight caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs synonym *Helminthosporium turcicum* (Pass.) is common in temperate areas and Maydis leaf blight caused by ascomycetous fungus *Cochliobolus heterostrophus* (Drechs.)

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[*Bipolaris maydis* (Nisikado and Miyake) Shoemaker] synonym *Helminthosporium maydis* (Nisikado) is common in tropical and subtropical regions (Payak and Sharma, 1983)^[12].

In India, Maydis leaf blight (*Bipolaris maydis*) is prevalent in almost all maize growing areas. Severe losses in grain yield due to epiphytotic have been reported in several parts of India and these losses vary from 25 to 90 per cent depending upon severity of the disease (Jha, 1993)^[2]. Maydis leaf blight of maize is also known as southern corn leaf blight. Earlier, the disease was considered minor, but now it has assumed the status of major disease in the world. Observed that disease epidemics at an early stage caused premature death of blighted leaves which lose their value as fodder (Payak and Renfro, 1968)^[12].

The incidence of this disease was first time reported by Drechsler (1925) from the United States. In India, it was reported for the first time by Munjal and Kapoor (1960)^[9] from Maldah (West Bengal). Southern corn leaf blight is considered to be one of the most devastating diseases as it appears in sizeable form resulting in the reduction of grain yield of maize by 2891 per cent (Payak and Sharma, 1985)^[13].

Disease symptoms appear in the form of small diamond-shaped spots (3-22 × 2-6 mm). The centre of each lesion is straw to light coloured, surrounded by a dark brown margin. These lesions elongate as they mature, although growth of the lesions is restricted by leaf veins. Symptoms may be confined to leaves or may develop on sheaths, stalks, husks, ears and cobs (Manamgoda *et al.*, 2014)^[7].

The management strategies are available for the management of this disease, yet there is a need to further refine them. The systematic information regarding the integrated management of the disease with respect to epidemiology, suitable use of biocontrol, along with use of botanicals with further researches for minimizing disease losses. Plant extracts represent a natural and ecological approach for managing diseases and provides many distinctive benefits to farmers, as they degrade quickly, have very short pre-harvesting intervals, and reduce the risk of residual effects on food.

2. Materials and Methods

Experimental site

The field experiment were carried out at the Central Research Field, Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj during *Kharif* season of 2023.

Preparation of plant extracts

The preparation of plant extracts begins with the collection of fresh leaves, which are then meticulously washed with clean water. Once cleaned, the leaves are air-dried and subsequently ground into a paste using a pestle and mortar. During this grinding process, sterilized distilled water is added in a weight-in-volume method, maintaining a ratio of 1:1 (w/v). The resulting extract is then filtered through a double-layered muslin cloth to remove any solid particles. The clear filtrate obtained is further diluted with sterilized distilled water to achieve the desired concentration. This final solution serves as a stock solution for further use in various applications, such as in pharmaceuticals, research, or natural remedies. The method outlined ensures that the

plant extracts are prepared in a sterile and controlled manner, suitable for experimental and practical purposes.

Table 1: Details of treatments

Sr. No	Treatments	Treatment Details
1.	T ₀	Control (Untreated)
2.	T ₁	<i>Trichoderma viride</i> (5gm/kg) S.T + Garlic clove extract (10%) F. S
3.	T ₂	<i>Trichoderma viride</i> (5gm/kg) S.T + Calotropis leaf extract (10%) F. S
4.	T ₃	<i>Trichoderma viride</i> (5gm/kg) S.T + Datura leaf extract (10%) F. S
5.	T ₄	<i>Trichoderma viride</i> (5gm/kg) S.T + Lantana camara (10%) F. S
6.	T ₅	<i>Trichoderma viride</i> (5gm/kg) S.T + Turmeric rhizome extract (10%) F. S
7.	T ₆	<i>Trichoderma viride</i> (5gm/kg) S.T + Ginger rhizome extract (10%) F. S
8.	T ₇	<i>Trichoderma viride</i> (5gm/kg) S.T + NSKE (10%) F. S

S.T- Seed Treatment

F.S- Foliar Spray

NSKE- Neem Seed Kernel Extract

Observations recorded

The observations on growth, development and its attributes which were recorded during the course of investigation are as follows.

Plant Height (cm)

The height of the plant was recorded in cm from base of the plant by using meter scale and selected five randomly plants in each plot of all replications at 30, 60 and 90 days after sowing.

Number of leaves

In each plot, count the leaves from the selected five plants of all the replication.

Yield (t/ha)

Yield of maize was taken at two different pickings in each treatment plot.

Disease intensity (%)

Disease intensity was recorded in five randomly selected plants tagging in each plot at 45, 60 and 75 days after sowing, disease intensity was observed as per the scale of Mayee and Datar (1986)^[8].

Percent Disease intensity was calculated by using the formula given below (Wheeler, 1969)^[15].

$$\text{Disease intensity (\%)} = \frac{\text{Sum of all individual disease rating}}{\text{Total number of plant examine} \times \text{Maximum disease grade}} \times 100$$

Table 2: Disease intensity grade scale

Grade	Leaf area Covered
1	No infection
2	10% area of leaf blighted
3	11-20% area of leaf blighted
4	21-30% area of leaf blighted
5	31-40% area of leaf blighted
6	41-50% area of leaf blighted
7	51-60% area of leaf blighted
8	61-70% area of leaf blighted
9	71-80% area of leaf blighted

3. Results and Discussion

3.1 Effect of treatments on plant height (cm)

The data of plant height (cm) at 30, 60 and 90 days after sowing depicted in the Table 3 at 30 days after sowing maximum plant height was recorded in T₇ - *Trichoderma viride* @ 5 g/kg + NSKE @10% (23.75 cm) followed by T₆ - *Trichoderma viride* @5 g/kg + Ginger rhizome extract @10% (22.45 cm) and least was observed in T₁ - *Trichoderma viride* @ 5 g/kg + Garlic clove extract (19.36 cm) as compared to T₀ - control (Untreated) (16.28 cm).

At 60 days after sowing maximum plant height was recorded in T₇ - *Trichoderma viride* @ 5 g/kg + NSKE @10% (109.26 cm) followed by T₆ - *Trichoderma viride* @5g/kg + Ginger rhizome extract @10% (108.38c m) and least was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract (105.28 cm) as compared to T₀ - control (Untreated) (104.51 cm).

At 90 days after sowing maximum plant height was recorded in T₇ - *Trichoderma viride* @ 5 g/kg + NSKE @10% (164.54 cm) followed by T₆ - *Trichoderma viride* @5 g/kg + Ginger rhizome extract @10% (163.57cm) and least was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract (160.49 cm) as compared to T₀ - control (Untreated) (159.41 cm).

Table 3: Effect of treatments on plant height (cm) at different time intervals of DAS of maize

Treatment No.	Treatment Detail	Plant height (cm)		
		30DAS	60DAS	90DAS
T ₀	Control (Untreated)	16.28	104.51	159.41
T ₁	<i>Trichoderma viride</i> + Garlic clove extract	19.36	105.28	160.49
T ₂	<i>Trichoderma viride</i> + Calotropis leaf extract	20.10	105.53	160.61
T ₃	<i>Trichoderma viride</i> + Datura leaf extract	20.40	106.19	161.73
T ₄	<i>Trichoderma viride</i> + Lantana camara	21.56	106.61	162.28
T ₅	<i>Trichoderma viride</i> + Turmeric rhizome extract	22.14	107.34	162.37
T ₆	<i>Trichoderma viride</i> + Ginger rhizome extract	22.45	108.38	163.57
T ₇	<i>Trichoderma viride</i> + NSKE	23.75	109.26	164.54
CD (5%)		0.35	0.49	0.44
S.Ed (±)		0.16	0.23	0.20

NSKE- Neem Seed Kernel Extract

DAS- Days After Sowing

3.2 Effect of treatments on number of leaves

The data of number of leaves at 30 days after sowing shown in the Table 3 at 30 days after sowing maximum number of leaves was recorded in T₆ - *Trichoderma viride* @ 5 g/kg + Ginger rhizome extract @10% (8) followed by T₇ - *Trichoderma viride* @5 g/kg + NSKE @10% (7.67) and least was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract (6.40) as compared to T₀ - control (Untreated) (6).

at 60 days after sowing maximum number of leaves was recorded in T₇ - *Trichoderma viride* @ 5g/kg + NSKE

@10% (14.73) followed by T₆ - *Trichoderma viride* @5g/kg + Ginger rhizome extract @10% (14.13) and least was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract (11.86) as compared to T₀ - control (Untreated) (9.80).

At 90 days after sowing maximum number of leaves was recorded in T₇ - *Trichoderma viride* @ 5g/kg + NSKE @10% (18.13) followed by T₆ - *Trichoderma viride* @5g/kg + Ginger rhizome extract @10% (17.93) and least was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract (16.26) as compared to T₀ - control (Untreated) (15.73).

Table 4: Effect of treatments on number of leaves at different time intervals of DAS of maize

Treatment No.	Treatment Detail	Number of leaves		
		30DAS	60DAS	90DAS
T ₀	Control (Untreated)	6	9.80	15.73
T ₁	<i>Trichoderma viride</i> + Garlic clove extract	6.40	11.87	16.27
T ₂	<i>Trichoderma viride</i> + Calotropis leaf extract	6.80	12.40	16.80
T ₃	<i>Trichoderma viride</i> + Datura leaf extract	6.60	12.93	17
T ₄	<i>Trichoderma viride</i> + Lantana camara	7.13	13.27	17.40
T ₅	<i>Trichoderma viride</i> + Turmeric rhizome extract	7.47	13.47	17.67
T ₆	<i>Trichoderma viride</i> + Ginger rhizome extract	8	14.13	17.93
T ₇	<i>Trichoderma viride</i> + NSKE	7.67	14.73	18.13
CD (5%)		0.29	0.42	0.30
S.Ed (±)		0.14	0.20	0.14

NSKE- Neem Seed Kernel Extract

DAS- Days After Sowing

3.3 Effect of treatments on disease intensity (%) of maize

The data of disease intensity (%) shown in the Table 4 at 45 days after sowing reveals that minimum disease intensity (%) was recorded in T₇ - *Trichoderma viride* @5g/kg + NSKE @10% (10.03%) followed by T₆ - *Trichoderma viride* @5g/kg + Ginger rhizome extract @10% (13.15%) and maximum was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract (23.73%) as compared to T₀ - control (25.17%).

At 60 days after sowing reveals that minimum disease intensity (%) was recorded in T₇ - *Trichoderma viride* @5g/kg + NSKE @10% (15.35%) followed by T₆ - *Trichoderma viride* @5g/kg + Ginger rhizome extract @10% (19.14%) and maximum was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract (30.92%) as compared to T₀ - control (33.44%).

At 90 days after sowing reveals that minimum disease intensity (%) was recorded in T₇ - *Trichoderma viride* @5g/kg + NSKE @10% (34.40%) followed by T₆ - *Trichoderma viride* @5g/kg + Ginger rhizome extract @10% (37.43%) and maximum was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract (50.78%) as compared to T₀ - control (53.59%).

Table 5: Effect of treatments on disease intensity (%) at different time intervals of DAS of maize

Treatment No.	Treatment Detail	Disease Intensity (%)		
		45 DAS	60 DAS	75 DAS
T ₀	Control (Untreated)	25.17	33.44	53.59
T ₁	<i>Trichoderma viride</i> + Garlic clove extract	23.73b	30.93	50.78
T ₂	<i>Trichoderma viride</i> + Calotropis leaf extract	22.48b	28.77	48.55
T ₃	<i>Trichoderma viride</i> + Datura leaf extract	21.06c	26.85b	46.47
T ₄	<i>Trichoderma viride</i> + Lantana camara	20.10c	25.95b	43.30
T ₅	<i>Trichoderma viride</i> + Turmeric rhizome extract	17.94	23.67	40.55
T ₆	<i>Trichoderma viride</i> + Ginger rhizome extract	13.15	19.15	37.43
T ₇	<i>Trichoderma viride</i> + NSKE	10.03	15.35	34.40
CD (5%)		1.26	1.23	0.50
S.Ed (±)		0.59	0.58	0.23

NSKE- Neem Seed Kernel Extract

DAS- Days After Sowing

3.4 Effect of treatments on yield (t/ha) and C:B ratio

The data of yield shown in the Table 5 reveals that maximum yield and C:B ratio was recorded in T₇ - *Trichoderma viride* @ 5 g/kg + NSKE @10% 4.4t/ha and 1.28 followed by T₆ - *Trichoderma viride* @5 g/kg + Ginger rhizome extract @10% 4.05 t/ha and 1.27 and least was observed in T₁ - *Trichoderma viride* @ 5g/kg + Garlic clove extract 2.85t/ha and 1.19 as compared to T₀ - control 2.5 t/ha and 1.14.

Table 5: Effect of treatments on Yield (t/ha) and C:B ratio

Treatment No.	Treatment Detail	Yield (t/ha)	C:B ratio
T ₀	Control (Untreated)	2.5	1.14
T ₁	<i>Trichoderma viride</i> + Garlic clove extract	2.9	1.19
T ₂	<i>Trichoderma viride</i> + Calotropis leaf extract	3.0	1.20
T ₃	<i>Trichoderma viride</i> + Datura leaf extract	3.2	1.21
T ₄	<i>Trichoderma viride</i> + Lantana camara	3.4	1.22
T ₅	<i>Trichoderma viride</i> + Turmeric rhizome extract	3.6	1.23
T ₆	<i>Trichoderma viride</i> + Ginger rhizome extract	4.05	1.27
T ₇	<i>Trichoderma viride</i> + NSKE	4.4	1.28

NSKE- Neem Seed Kernel Extract

The effects of various treatments on the Southern leaf blight of maize caused by *Bipolaris maydis* reveals significant findings regarding the effect of different combinations of *Trichoderma viride* with various plant extracts. The study evaluated that plant height (cm) at three different time of interval: 30, 60, and 90 days after sowing (DAS). The treatment with *Trichoderma viride* combined with NSKE (T₇) showed the highest plant height followed by T₆, T₅, T₄, T₃, T₂ and T₁ while the untreated control (T₀) had the least plant height (cm).

NSKE effectively inhibits the germination of fungal spores and the growth of mycelium, disrupting the fungal life cycle Wahedi *et al.* (2016) [16]. Active compounds in neem, such as azadirachtin, interfere with the metabolic processes of fungi, leading to cell death. NSKE can enhance the natural defense mechanisms of plants by triggering the production of phytoalexins and other defensive compounds Pavan and Poonam (2021). NSKE may affect the integrity of fungal cell membranes, leading to leakage of cellular contents and

eventual cell death, which is critical for controlling fungal pathogens Kumar (2020) [51].

4. Conclusions

In the present study based on the observations, the *in-vivo* results revealed that seed treatment with *Trichoderma viride* @ 5 g/kg and foliar spray with NSKE was found most effective in minimum disease intensity (%) and maximum plant height (cm), number of leaves and yield (t/ha) among all treatments. The probable reasons for such findings may be due to the presence of triterpenoids, e.g., nimbin, nimbidine, azadirachtol, nimlinone, nimbinol, nimocin etc., in NSKE and from *T. viride viz.* extracellular β -(1, 3)-glucanase, proteases, lipases and chitinases it was concluded that NSKE were found as best treatment to manage for Southern leaf blight of maize disease. The findings of the present experiment were limited to one crop season (July 2023 to September 2023) under Prayagraj, Uttar Pradesh agro-climatic conditions, as such to validate the present findings more such trials should be carried out in future.

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