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Research paper on study of phytotoxic metabolites of Alternaria alternata for the management of pathenium hysterophorus L

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Abstract- Parthenium hysterophorus is one of the most harmful invasive weeds affecting agricultural biodiversity, human health, and livestock productivity. Chemical herbicides are commonly used for its management, but their continuous use causes environmental pollution and herbicide resistance. Biological control using phytopathogenic fungi has emerged as an eco-friendly alternative. Alternaria alternata produces several phytotoxic metabolites that possess herbicidal properties against weeds. The present study focuses on the isolation, extraction, and evaluation of phytotoxic metabolites produced by Alternaria alternata for the management of Parthenium hysterophorus. Various bioassays, such as seed germination inhibition, detached leaf bioassay, and whole-plant studies, demonstrated significant phytotoxic effects of the fungal metabolites. The study suggests that these fungal metabolites may serve as potential bioherbicides for sustainable weed management.

Keywords- Parthenium hysterophorus, Alternaria alternata, Bioherbicide, Phytotoxic metabolites, Biological weed control, Sustainable agriculture, Seed germination inhibition.

I. Introduction

Parthenium hysterophorus, commonly known as Congress grass or carrot weed, is an invasive annual weed belonging to the Asteraceae family. It has spread rapidly in tropical and subtropical regions, causing severe losses in crop productivity and environmental health. The weed produces allelochemicals that suppress surrounding vegetation and may cause allergies and respiratory problems in humans.

Biological weed control using phytopathogenic fungi, also called mycoherbicides, have gained considerable importance. Among various fungi, Alternaria alternata is known for producing toxic secondary metabolites such as Tenuazonic acid, Alternariol, and Alternariol monomethyl ether. These metabolites exhibit strong phytotoxic effects on several weed species, including Parthenium hysterophorus.

II. Materials and Methodology

Isolation and Identification of Fungus

The infected leaf tissues were surface sterilized and inoculated on Potato Dextrose Agar (PDA) medium. After incubation, the fungal colonies were purified and identified on the basis of colony morphology and microscopic characteristics.

Production of Fungal Metabolites
Pure cultures of Alternaria alternata were grown in liquid broth medium under controlled laboratory conditions. The cultures were maintained for different incubation periods of 7, 14, 21, and 28 days. After incubation, the culture filtrate was separated through filtration.

Four different broth samples were prepared using cultures of Alternaria alternata corresponding to 7-day, 14-day, 21-day, and 28-day incubation periods. Plant samples were collected from the Vijayanagar side, MR Road, Zone C.

For phytotoxicity testing, different concentrations of culture filtrate were prepared in separate jar bottles as follows:
- 25% culture filtrate + 75% distilled water
- 50% culture filtrate + 50% distilled water
- 75% culture filtrate + 25% distilled water
- 100% pure culture filtrate

LEAF BIOASSAY
The leaf bioassay was conducted to evaluate the percentage of leaf damage caused by fungal metabolites. Five Petri dishes lined with Whatman filter paper were used for the experiment. Healthy leaves of Parthenium hysterophorus were treated with different concentrations of metabolite extracts. The treated leaves were observed for symptoms such as chlorosis, necrosis, and tissue damage.

SEED GERMINATION BIOASSAY
Seeds of Parthenium hysterophorus were treated with different concentrations of fungal metabolites. Germination percentage and seedling growth were recorded.
For the experiment, five Petri dishes lined with filter paper were used, and 10 seeds were placed in each Petri dish. The time taken for seed germination and the number of germinated seeds were carefully observed and recorded.

SHOOT-CUT BIOASSAY
Five test tubes were prepared with different concentrations of fungal metabolites. Healthy shoot cuttings of Parthenium hysterophorus were placed in the test tubes containing the metabolite solutions. The shoot cuttings were observed for symptoms of wilting and damage after a few days of treatment.

III. Results

7-Day Broth
- Leaf bioassay – 50% Result
- Seed germination bioassay – 75% Result
- Shoot-cut bioassay – 25% Result 14-Day Broth
- Leaf bioassay – 75% Result
- Seed germination bioassay – 75% Result
- Shoot-cut bioassay – 25% Result 21-Day Broth
- Leaf bioassay – 25% Result

- Seed germination bioassay – 75% Result
- Shoot-cut bioassay – 25% Result
- 28-Day Broth
- Leaf bioassay – 25% Result
- Seed germination bioassay – 50% Result
- Shoot-cut bioassay – 75% Result

Whole-Plant Study

The phytotoxic metabolite solution was sprayed on whole plants of Parthenium hysterophorus, and observations were recorded at different time intervals:

- 3rd day – 25% damage observed
- 5th day – 50–75% damage observed
- 7th day – 75% damage observed

IV. Conclusion

The present study demonstrates that phytotoxic metabolites produced by Alternaria alternata are highly effective against Parthenium hysterophorus. These metabolites significantly inhibit seed germination and plant growth, indicating their potential as natural bioherbicides.

The use of fungal metabolites offers an environmentally safe and sustainable alternative to chemical herbicides. Further research on purification, formulation, and field application may help in the commercial development of mycoherbicides for effective weed management.

References

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