Journal of Research in Weed Science

Journal homepage: www.jrweedsci.com

Original Research Article

Diseased weeds and weed pathogens of paddy fields in Devarapalli Mandal, West Godavari District, Andhra Pradesh, India

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ARTICLE INFORMATION

Received: 19 June 2019

Revised: 9 July 2019

Accepted: 17 July 2019

Available online: 18 July 2019

DOI: 10.26655/JRWEEDSCI.2020.1.4

KEYWORDS

Isolation
Pathogenicity
Potato Dextrose Agar (PDA)
Quadrant
Weed infestation

ABSTRACT

Weeds are responsible for heavy yield losses in rice, to the extent of complete crop failure under severe infestation conditions. They occur in every field of rice (*Oryza sativa*) in the world which is the vital food for more than two billion people in Asia. A systematic field study was conducted in paddy field of Devarapalli Mandal, West Godavari District, Andhra Pradesh, India. Infested weeds were collected in paddy field crops for plants identification, observation, and collection. The random quadrant method was adopted for this study. The collected diseased weed plants were carried out for the extensive study on symptoms, isolation and pathogenicity of the organisms that involved in leaf spot diseases. The causal agents of diseased weed plants were isolated. The inoculated fungal pathogens are incubated on PDA for pure cultures. After harvesting of spores they were observed under the microscope. The study is used to know host specificity of isolated fungal pathogens on test plants and also used to identify bio control agents for crop development. Investigator hopes that diseased weeds of rice fields in study area provide good source of information of technical and taxonomic data to the academic institutes and research organizations like Agricultural colleges, Universities, Agricultural Universities and other agricultural agencies.

Introduction

India is a progressing country in the world. Agriculture is an important sector of Indian Economy; as it contributes about 17% to the total GDP and provides employment to over 60% of the population. Over 70 % of the rural households depend on agriculture. India is the world's largest producer of pulses, rice, wheat, spices and spice products. Paddy (*Oryza sativa*) is one of the most important food crops of the world and is the second emerging crop in India after wheat. Being staple food it plays an important role in the economy of India hence occupies a central position in

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agricultural policy making (Dangwal et al. 2010). However, stable production of rice has been limited by many diseases, insects, and weeds. There are several reasons for its low productivity but the infestation of weeds is one of the most important causes for low yield of rice in India. Weeds are considered a major constraint to world rice production (Moody, 1995).

Weeds are often called out of place. They are unwanted, prolific, competitive, and often harmful to the crop ecology. Weed is a plant which is judged by man to be not of use and undesirable at a place where it flourishes (Patil et al. 2010). Weeds due to their long seed life in soil, quick emergence, and ability to survive and prosper, they grow rapidly in fields. Weeds reduce crop yields by depriving the crops for the water, light and soil nutrients they need. Weeds are a major impediment to rice production due to their ability to compete for resources. Weed control in agriculture requires knowledge of weed biology, weed ecology, etc. Although weeds have been eradicated using various cultural practices. Commonly used weed control strategies are water management, hand weeding, mechanical weeding and chemical herbicides. During the extensive surveys conducted by the authors in the agricultures fields, the heavy weed infestation was observed in various crop fields. Several workers have earlier reported heavy infestation of weeds in agricultural crops of study area. Some of the weeds may be controlled by fungal isolates. They are used as bio control agents to eradicate weeds for better crop yield. The aim of this study was to evaluate the diseased weeds and weed pathogens of paddy fields in Devarapalli Mandal, Andhra Pradesh, India.

Materials and Methods

Site location

The area under study was based on extensive and intensive field surveys for weed plants collection. The present study deals with weeds of paddy fields in Devarapalli Mandal of West Godavari District. The district is situated in coastal Andhra region of the state with geographical area of 7742 square kilometres. West Godavari situated between 16° - 15'-00 to 17° -30'-00" Northern latitude and 80° -55'-00" to 81° -55'-00" Eastern Longitude. It is bounded on the north by Khammam district (Telangana state), on the south by Krishna District and Bay of Bengal on the east by Godavari River and on the west by Krishna district. Devarapalli is situated in 17° 1′ 48″ N, 81° 22′ 12″ E. Agriculture is the main occupation of this area. Rice is the staple food of the people and therefore paddy is the principal food crop of the District. The cultivated fields of West Godavari district, Andhra Pradesh is infested with a large number of weeds compressing heavy losses to the crop yields.

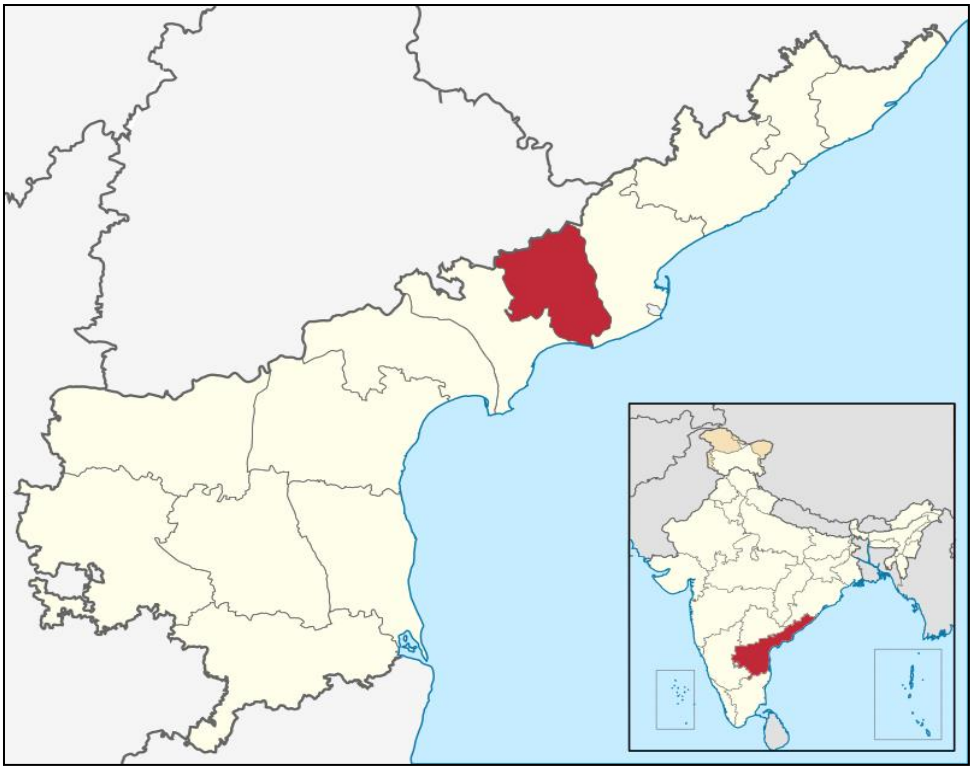


Figure 1. Location map of District West Godavari District.

Figure 2. Mandal wise map of West Godavari.

Weed survey

The exploration of the area under study includes the planned field trips to the crop fields for diseased weed plants identification, observation, and collection. Each fieldtrip includes 2-3 days covering a particular area, during the *Kharif* season. After identification, the diseased weed plants are collected in polythene bags and brought to the laboratory of Department of Botany, Andhra University. These weed plants were maintained in the laboratory for the extensive study on symptoms, isolation and pathogenicity of the organisms that involved in leaf spot diseases. The random quadrant method was adopted for this study to note down the presence of weed species among the crop fields. Abundance, density and frequency and their relative values and importance value index (IVI) were calculated by applying the following principles of Curtis and Mc-Intosh (1950), Misra (1968) and Muller-Dombois and Ellenberg (1974).

$$\text{Frequency} = \frac{Total\ number\ of\ quadrates\ in\ which\ the\ species\ occur}{Total\ number\ of\ quadrates\ studied} \times 100$$

$$\text{Density} = \frac{Total\ number\ of\ individuals\ of\ a\ species\ in\ all\ quadrates}{Total\ number\ of\ quadrates\ studied}$$

$$\text{Abundance} = \frac{Total\ number\ of\ individuals\ of\ a\ species\ in\ all\ quadrates}{Total\ number\ of\ quadrates\ in\ which\ the\ species\ occurred}$$

$$\text{Relative Frequency} = \frac{Frequency\ of\ individuals\ of\ a\ species}{Total\ frequency\ of\ all\ species} \times 100$$

$$\text{Relative Density} = \frac{Density\ of\ individuals\ of\ a\ species}{Total\ density\ of\ all\ species} \times 100$$

$$\text{Relative Abundance} = \frac{Abundance\ of\ individuals\ of\ a\ species}{Total\ abundance\ of\ all\ species} \times 100$$

$$\text{Important Value Index} = Relative\ Density + Relative\ Frequency + Relative\ Abundance$$

Herbarium

The collected plant samples are pressed in a plant press (to flatten and dry), which consists of a wooden frame (for rigidity), corrugated cardboard ventilators (to allow air to flow through the press), blotting paper (to absorb moisture), and folded paper, preferably a newspaper (to sustain the plant material). The plant pressed is tightened using straps with buckles. The main objective of pressing plants is to extract moisture in the shortest period of time, while preserving the

morphological integrity of the plant, and to yield material that can be readily mounted on herbarium sheet for long term storage.

Identification of weeds

After completing the weed collection from the crop fields, the weed flora was identified by the help of floras, monographs and other relevant literature and consequently the correct scientific and common names were provided to each plant. Each plant was critically studied and identified using the 'Flora of British India' (Hooker, 1872), 'Flora of Presidency of Madras' (Gamble and Fischer, 1915),'Flora of Andhra Pradesh' (Pullaiah and Chennaiah, 1997), and flora of west Godavari district (Sesagiriravu et al. 1986).

Soil analysis

The soil sample in the field area under study is collected and sent to laboratory for soil analysis. It determines the amount of available plant nutrients in the soil, and also the chemical, physical and biological soil properties important for plant nutrition, or soil health. Soil analysis is used to assess the potential for soil to produce plants, and for soil amendments. It also acts as a basis for determining fertilizer requirements for meeting plant and crop needs. It is beneficial to take supporting decisions relating to soil improvement, land utilisation, environment protection and human health. The characteristics of soil, nutrients availability, of soil sample in study area is recorded in table 1.

Table1. Soil properties of study area.

Soil characteristics	**Observed values**
Color	Dark brown
Type	Sandy clay loam
Hydrogen	6.8
Soluble salts	0.16
Macronutrients (Kg.Ha^{-1})	
Phosphorus	15
Potash	11
Micronutrients (ppm)	
Zinc	0.44
Iron	83.28
Manganese	17.12
Copper	2.90

Isolation and inoculation of fungal pathogens

The diseased leaves were washed thoroughly in running tap water to remove soil particles and the infected portions of the leaves were cut into 1.0 – 1.5 cm. fragments. The pieces were surface sterilised by sterile distilled water for 2-3 times followed by 70% ethyl alcohol for 1-2 minutes and then rinsed in sterile distilled water for 2 to 3 times. Finally the leaf bits were rinsed in 0.01% mercuric chloride for 30 seconds followed by washing with sterile distilled water for 2 or 3 times. These fragments were transferred on to Potato dextrose agar (PDA) plates supplemented with 1% streptomycin sulphate (antibiotic) under completely sterile conditions in an isolation chamber. After inoculation plates were incubated at 28 ±2°C for 21 days on a 12 h light/dark photoperiod. The Petri dishes were incubated with artificial light supplied by fluorescent light. Pure cultures of fungi were maintained for the harvesting of spores and observed under microscope.

Results and Discussion

The paddy field crops in Deverapalli Mandal of West Godavari District were heavily infested with innumerable weed species. Common weeds in rice fields are grouped into three categories grasses, sedges and broad leaved weeds. Grasses are the monocots; leaves are usually long, narrow and upright with parallel venations. The stems are more or less round in shape, possess nodes, internodes are generally hollow with scattered vascular bundles (*Echinochloa crussgalli etc.)*. In Sedges the stems are usually triangular and they won't possess nodes and internodes. Several species have modified rhizomes which are used for food storage and propagation. (*Cyperus rotundus,* etc). Broad leaved weeds are usually dicots with tap root system. The stem has branches and leaves with reticulate venation. (*Eclipta alba,* etc). Numerous plant species are considered as weeds in agronomic cropping systems due to their harmful effects in agricultural fields. Weed plants in paddy fields are infected with fungal pathogens. The weed plant pathogens interact with other hosts and causes serious loses and damages to the agricultural products. The present study deals with weed plant pathogens of paddy fields in Devarapalli mandal of West Godavari district, Andhra Pradesh. In this study a total of 23 diseased weed plants are identified. Among the identified species 3 are grasses, 2 are sedges and 18 are broad leaved weeds. The plant descriptions of diseased plants are recorded in Table-2. Some diseased weeds are common some are frequent and rare. Most frequent diseased weed plants are *Alternanthera sessilis, Commelina benghalensis, Ludwigia parviflora, Melochia corchorifolia, Vernonia cinerea.* Few diseased weeds are rare that includes *Ageratum conyzoides, Alternanthera paronychioides, Corchorus aestuans, Digitaria sanguinalis*, and *Synedrell nodiflora*. The most predominant 5 diseased weed plants of study area are recorded in Figure 3.

The weeds like *Alternanthera sessilis, Ludwigia parviflora* are showing the maximum infestation in rice fields of study area. *Alternanthera sessilis,* commonly called as joy weed, is one of the prominent diseased weed of the present study. This weed is a widely spread over most of the tropical countries. It is a weed in many different agricultural crops.

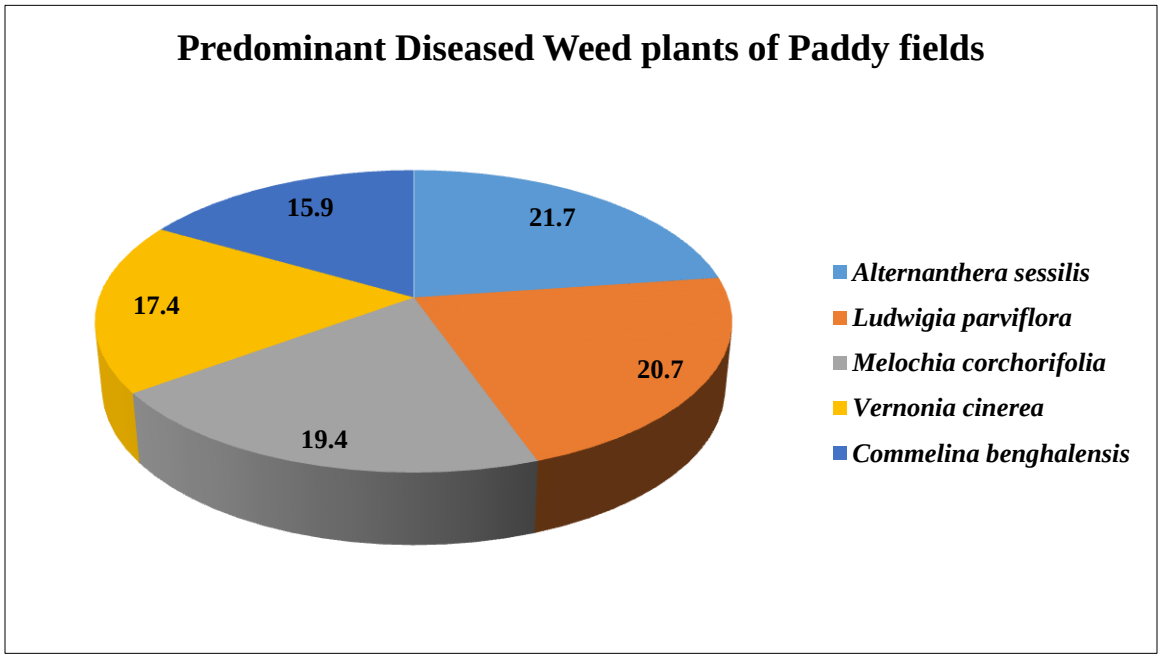


Figure 3. List of top 5 diseased weed species based on IVI, in rice fields of Devarapalli Mandal, West Godavari district, Andhra Pradesh, India.

Ludwigia parviflora is also one of the most infested weed in rice fields. It's commonly called as water primrose. This weed is cosmopolitan in distribution. It is a broad leaved weed generally dicot with tap root system. It is one of the worst weed and may compete heavily with the crop plants for nutrients and water. The diseased weed plants are studied through random quadrate method. Total numbers of 10 quadrates are studied in the field area. The data pertaining to abundance, density, frequency and their relative values for determining the distribution pattern and Importance Value Index (IVI) of the diseased weeds in paddy fields under the study area are provided in Table 3. A total number of 23 diseased weeds were identified. The Importance Value Index (IVI) is calculated for the individual diseased weed species encountered in paddy fields. *Alternanthera sessilis* is most predominant species followed by *Ludwigia parviflora.* The infected weeds are brought to the laboratory for the isolation of pathogens. Out of 23 diseased weed species, most predominant 4 diseased weeds were isolated. The diseased leaves were washed thoroughly for removing soil particles. Diseased spots on the leaves were cut into small fragments. Surface sterilization of the infected leaf fragments is done before isolation. The fragments of diseased weed leaves were

incubated on Potato Dextrose Agar (PDA). Pure cultures were maintained for harvesting spores. Extraction of spores from lesions found on the infected leaves is the most appropriate isolation technique. The harvested spores were observed under the microscope. Spores need to be identified by the Microbial Type Culture Collection and Gene Bank (MTCC) which is housed at the Institute of Microbial Technology (IMTECH), Chandigarh. The result of the present investigation revealed with work done was recorded in the Figures 1-4.

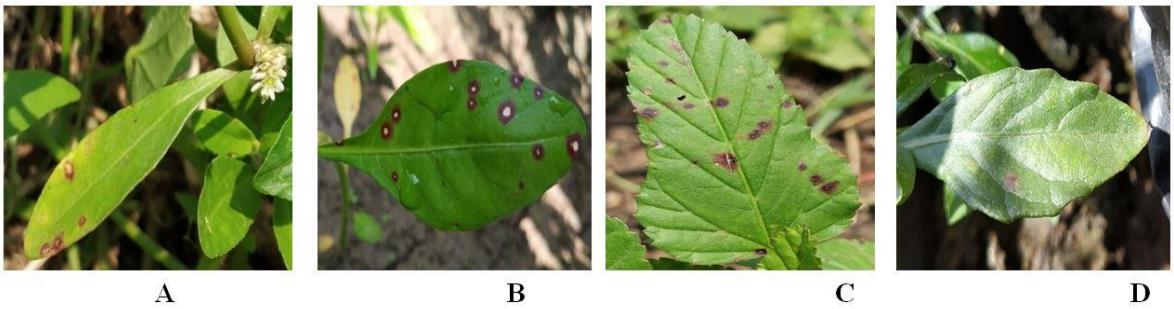
Table 2. Plant description of diseased weeds in paddy fields of study area.

S.no	Botanical name	Family	Plant description	Method of propagation	Weed status
1	*Achyranthes aspera*	Amaranthaceae	erect or prostrate, annual or perennial	Vegetative	common
2	*Ageratum conyzoides*	Compositae	Erect branched annual	Seeds	rare
3	*Alternanthera sessilis*	Amaranthaceae	annual or perennial	Vegetative and seeds	frequent
4	*Alternanthera paronychioides*	Amaranthaceae	Prostrate herb, perennial	Seeds	rare
5	*Chloris barbata*	Poaceae	Tufted annual grass	Seeds	common
6	*Commelina benghalensis*	Commelinaceae	perennial annual herb	Seeds	frequent
7	*Corchorus aestuans*	Malvaceae	Erect, Annual	Seeds	rare
8	*Cyperus rotundus*	Cyperaceae	Erect, glabrous perennial	Seeds, tubers, rhizomes	common
9	*Eclipta alba*	Asteraceae	Erect or prostrate	Seeds	common
10	*Digera muricata*	Amaranthaceae	Annual	Seeds	common
11	*Digitaria sanguinalis*	Poaceae	Annual, prostrate	Seeds/plant	rare
12	*Euphorbia hirta*	Euphorbiaceae	Erect or prostrate annual	Seeds	common
13	*Eleusine indica*	Poaceae	Annual	Seeds	common
14	*Ludwigia parviflora*	Onagraceae	Perennial erect	Seeds	frequent
15	*Melochia corchorifolia*	Malvaceae	Annual or perennial	Seeds	frequent
16	*Monochoria vaginalis*	Pontederiaceae	Annual or perennial	Whole plants or seeds	common
17	*Panicum repens*	Poaceae	perennial	Rhizomes	common
18	*Sida cordifolia*	Malvaceae	perennial,	Seeds, root	common
19	*Synedrella nodiflora*	Asteraceae	Erect annual herb	Seeds	rare
20	*Trianthema portulacastrum*	Aizoaceae	Prostrate or ascending succulent	Seeds	common
21	*Tridax procumbens*	Asteraceae	Annual sometimes perennial prostrate	Seeds	common
22	*Urena lobata*	Malvaceae	Annual, erect, ascendant under shrub	Seeds	common
23	*Vernonia cinerea*	Asteraceae	Annual	Seeds	frequent

Table 3. Calculation of frequency, density, abundance, R.F, R.D, R.A, IVI of Diseased weeds in paddy fields.

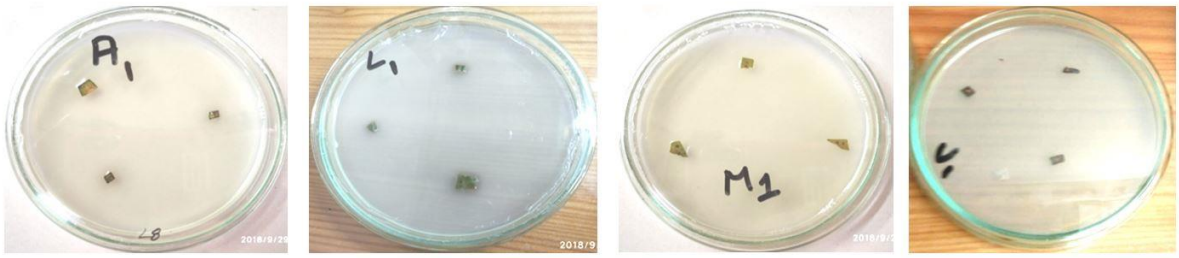
Weeds	TNI*	N*	F*	D*	A*	R.F*	R.D*	R.A*	IVI*
Achyranthes aspera	21	3	30	2.1	7	2.6	4.5	7.4	14.5
Ageratum conyzoides	15	4	40	1.5	3.7	3.5	3.2	3.9	10.6
Alternanthera sessilis	42	6	60	4.2	7	5.3	9	7.4	21.7
Alternanthera paronychioides	11	5	50	1.1	2.2	4.4	2.3	2.3	9
Chloris barbata	22	6	60	2.2	3.6	5.3	4.7	3.8	13.8
Commelina benghalensis	27	5	50	2.7	5.4	4.4	5.8	5.7	15.9
Corchorus aestuans	10	4	40	1	2.5	3.5	2.1	2.6	8.2
Cyperus rotundus	14	5	50	1.4	2.8	4.4	3	2.9	10.3
Eclipta alba	17	5	50	1.7	3.4	4.4	3.6	3.6	11.6
Digera muricata	15	4	40	1.5	3.7	3.5	3.2	3.9	10.6
Digitaria sanguinalis	13	4	40	1.3	3.2	3.5	2.8	3.4	9.7
Euphorbia hirta	26	6	60	2.6	4.3	5.3	5.6	4.5	15.4
Eleusine indica	16	5	50	1.6	3.2	4.4	3.4	3.4	11.2
Ludwigia parviflora	40	7	70	4	5.7	6.1	8.6	6	20.7
Melochia corchorifolia	36	6	60	3.6	6	5.3	7.7	6.4	19.4
Monochoria vaginalis	14	5	50	1.4	2.8	4.4	3	2.9	10.3
Panicum repens	15	5	50	1.5	3	4.4	3.2	3.2	10.8
Sida cordifolia	18	5	50	1.8	3.6	4.4	3.8	3.8	12
Synedrella nodiflora	10	4	40	1	2.5	3.5	2.1	2.6	8.2
Trianthema portulacastrum	13	4	40	1.3	3.2	3.5	2.8	3.4	9.7
Tridax procumbens	17	5	50	1.7	3.4	4.4	3.6	3.6	11.6
Urena lobata	21	3	30	2.1	7	2.6	4.5	7.4	14.5
Vernonia cinerea	31	7	70	3.1	4.4	6.1	6.6	4.7	17.4
Total	464	113	1130	46.4	93.6	99.2	99.1	98.8	297.1

*TNI- Total number of individual species.,*N-Number of quadrants in which individual species present.,*F-Frequency.,*D-Density., *A- Abundance., *R.F - Relative frequency; * R.D – Relative density; *R.A – Relative abundance; * IVI - Important value.



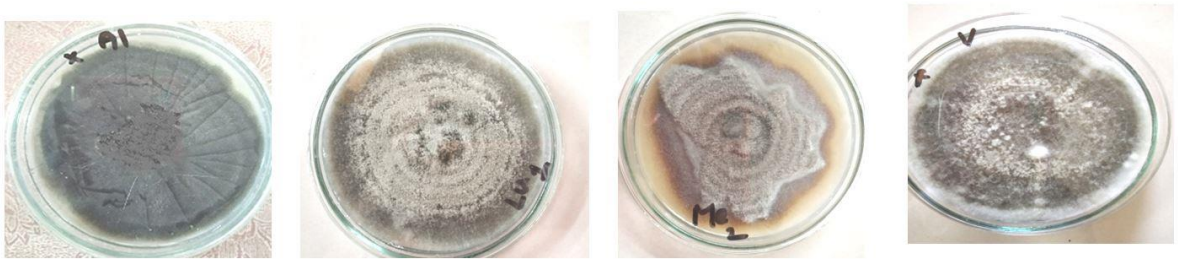
A B C D

Figure 1. Agricultural weeds infested with symptoms of fungal diseases.



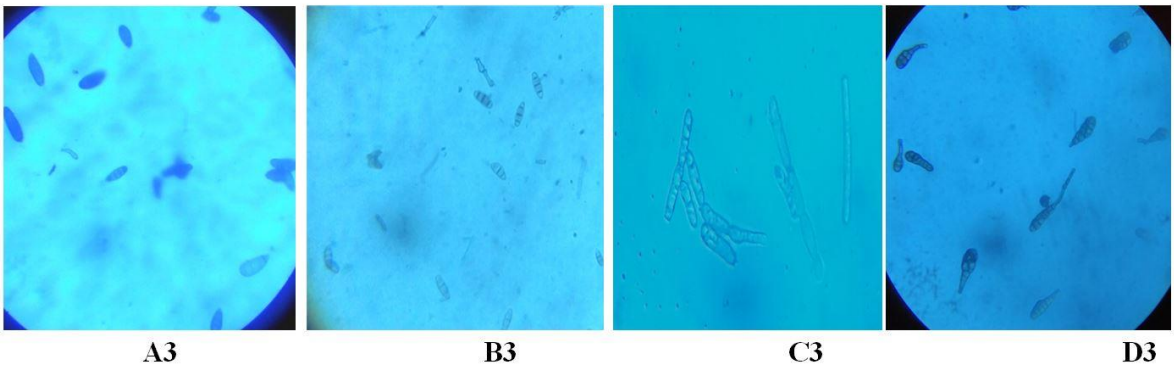
A1 B1 C1 D1

Figure 2. Isolation of pathogenic fungi from plant leaves.



A2 B2 C2 D2

Figure 3. Pure cultures of isolated fungi on PDA plates



A3 B3 C3 D3

Figure 4. Microscopic structure of isolated fungi and spores appearance.

A, A1, A2, A3: *Alternanthera sessilis*
B, B1, B2, B3: *Ludwigia parviflora*
C, C1, C2, C3: *Melochia corchorifolia*
D, D1, D2, D3: *Vernonia cinerea*

Conclusion

This study will help to know the fungal pathogens, and thus assist in planning a suitable strategy for their control as these weeds compete with paddy crop for resources and hence reduce its yield. The fungus which is isolated from diseased weed plants is used to study host- specific interactions. Isolates of fungal pathogens behave as a bio control agents to some test plants. Bio control agents show pathogenic nature on some serious weeds of many countries and released into market as commercial myco-herbicides. Recently the awareness of biological control methods was developed among the farmers and agronomists, researchers and plant breeders in India. The study on pathogenicity of fungal pathogens is more useful for the future steps and development of new methods in biological control of agricultural weeds by indigenous fungal pathogens.

Acknowledgement

Authors were grateful to Department Botany, Andhra University for providing all the lab facilities for this study. Also, they were thankful to farmers for sharing their valuable information.

Conflicts of Interest

No conflicts of interest have been declared.

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Cite this article as: Spandana Dondapudi, Ranta Kumar P.K , Indhu Keerthana P. 2020. Diseased weeds and weed pathogens of paddy fields in Devarapalli Mandal, West Godavari District, Andhra Pradesh, India. *Journal of Research in Weed Science*, 3(1), 36-47. DOI: 10.26655/JRWEEDSCI.2020.1.4