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RESEARCH ARTICLE

WEED FLORA AND DIVERSITY OF RICE AGRO-ECOSYSTEMS IN VISAKHAPATNAM DISTRICT OF ANDHRA PRADESH, INDIA

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ABSTRACT

The study was conducted to assess the phytosociological studies of weed species in rice fields of Visakhapatnam District, Andhra Pradesh. The survey has been carried out at 100 randomly selected rice fields and well explored covering all the geographical areas of Visakhapatnam district, to identify the weed flora, species composition, density, frequency and importance values index (IVI). A total of 80 plant species, belonging to 75 genera and 29 families were identified. Among the 29 families have been recorded, out of these 16 families are representing each species. Poaceae is the largest family representing 15 species. The results of phytosociological studies revealed that the species *Bacopa monnieri* (4.2) is most abundant weed in rice field followed by *Ammania baccifera* (4.0), *Chromolaena odorata* (3.2), *Merremia gangetica* (3.1) and *Marsilea quadrifolia* (2.8), these five species were concluded as the most competent weeds which enter into real competition with the rice crop.

INTRODUCTION

Paddy (*Oryza sativa* L.) is one of the most important food crops of the world and more than half of the human race depends on rice for their daily sustenance and it is the second emerging crop in India after wheat. India is the second largest producer of rice after China (Savary *et al*., 2005). Beside its use for human food, paddy is a source for number of industrial products like rice starch, rice bran oil, flaked rice, puffed rice and rice husk etc. Being staple food it plays an important role in the economy of India hence occupies a central position in agricultural policy making (Dangwal *et al*., 2010). The average per hectare yield of paddy in India is less as compared to China due to many factors like shortage and high cost labor; lack of irrigation facilities, quality of germplasm, agricultural output and ecological conditions etc., but the problems of weed is the major contributor in the loss of production. 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). Generally Weeds are unwanted and undesirable plants growing in a place where some other desirable plants are grown or where no plantation is needed at all. The plants growing in agricultural fields, having more negative values, and competing with the main crops for soil, water, nutrients etc. An ecological survey of weed flora is must for a comprehensive idea of weed problem. Understanding the sociological structure of weeds in crop fields is a pre-requisite for its effective management.

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Identification and quantification of weed species present in rice cropping system is possible to provide strategies for weed control methods in rice crops that can be adapted by marginal farmers. The study area is located at 17^0 – 15' and 18^0 – 32' Northern latitude and 18^0 – 54' and 80^0 – 30' in Eastern longitude. Visakhapatnam District with an area of 11,161 lakhs hectors is one of the north eastern coastal districts of Andhra Pradesh. Study area is bounded on the North by the Odisha state and by Vizianagaram district, on the South by East Godavari district, on the West by Odisha state and on the East by Bay of Bengal. Earlier some workers conducted a survey in North Costal Andhra Pradesh to highlight the distribution of different weed species in all agricultural fields (Nagaraju *et al*., 2014; Murty and Venkaiah, 2012). However, no such reference exists in the weeds of rice fields from Visakhapatnam district.

MATERIALS AND METHODS

The present study deals with weeds of paddy fields in Visakhapatnam District. The study was based on extensive and intensive field surveys made during different months of Kharif season. During the course of field study the authors have selected 100 important paddy growing fields in the study area covering all the geographical areas of the district, to identify the weed flora, species composition, density, frequency and importance value Index (IVI). Rice is most dominant and significant irrigated field crop of this area, verities Srikakulam Sannalu (RGL-2537) crop duration 150-160 days, Srikurma (RGL-2332) crop duration 130-140 days, Vijeta (MTU-1001) crop duration 120-130 and Sambamasuri (BPT-5204) Crop

duration 140-150 are cultivating by the farmers in the study area. The rice crop with these varieties was selected for the phytosociological investigations in selected field sites. The studies were conducted before weeding during period 2012-2013 Kharif seasons (June-October) for the weeds inventory survey and phytosociological investigations. Field surveys at 100 random rice fields have been well explored covering all the geographical areas of Visakhapatnam district for weed survey and phytosociological studies. The weeds encountered in the field sites of the above crop fields were carefully collected and identified. Random quadrate method was adopted for weed survey and studying phytosociological attributes of weeds. All the weeds from each quadrate were collected separately in polythene bags. After completing the weed collection from the rice crop fields, the specimens were identified by comparing with the authentic certified specimens at the Andhra University herbarium, Department of Botany and Central National Herbarium (CAL) Howrah (for some grasses). Later, these identifications were checked again at the regional herbarium or in the laboratory with the help of floras, monographs and other relevant literature and consequently the correct name were provided to each plant. Abundance, density and frequency and their relative values and importance value index (IVI) were calculated by applying the following principles of Curtis and Mclntosh (1950), Misra (1968) and Muller-Dombois and Ellenberg (1974).

Frequency

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

Density

$$= \frac{\text{Total number of individuals of a sepcies inall quadrates}}{\text{Total number of quadrates studied}}$$

Abundance

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

Relative frequency

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

Relative density

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

Relative abundance

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

Important Value Index = Relative density + Relative frequency + Relative abundance

RESULTS AND DISCUSSION

Phytosociology is the study of all phenomena and effects regarding social life of plants (Braun-Blanquet, 1932). A plant may react with close proximity of neighbors (weed) by failure to survival with plastic development (Alam, 1991). Weeds are a persistent problem in agricultural production systems and increased production costs, resulting in high economic loses (Saritha, 2013). In India, weeds pose a serious problem in crop production. Because of lack of knowledge and financial resources, the smaller farmers cannot afford to remove them from their fields. In the present study a total of 80 weeds species belonging to 57 genera and 29 families were identified as rice crop weeds in the study area. Among the identified species 50 were dicots, 29 were monocots and one pteridophyte exclusively recorded from rice fields (Table-1). Out of 29 families 16 are monotypic, viz., representing only one species each these are Amaranthaceae, Aponogetonaceae, Boraginaceae, Campanulaceae, Hydrocharitaceae, Lythraceae, Marseliaceae, Mimosaceae, Molluginiaceae, Nyctaginaceae, Oxalidaceae, Polygalaceae, Solanaceae, Sterculiaceae, Verbenaceae, Zygophyllaceae. Poaceae is the largest family representing with 15 species, Convolvulaceae occupies the second position with 8 species, Cyperaceae with 7, Scrophulariaceae and Asteraceae 6 species each, Fabaceae, Acanthaceae, Commelinaceae, Rubiaceae, Onagraceae, Polygonaceae with 3 species each, Lemnaceae and Euphorbiaceae with 2 species each. Genera *Fimbristylis* and *Lindernia* are representing 4 species each followed by *Ludwigia*, *Merremia* and *Polygonum* 3 species each, *Commelina, Cyperus, Echinochloa, Euphorbia, Evolvulus, Hedyotis, Ipomoea* and *Tephrosia* representing 2 species each.

Table 1. Analysis of rice weed species of the study area

Traditional plant group	Families	Species
Dicotyledons:		
Polypetalae	9	13
Gamopetalae	9	30
Monochlamydae	4	7
Monocotyledons	6	29
Pteridophytes	1	1
Total	29	80

The data pertaining to abundance, density, frequency and their relative values for determining the distribution pattern and Importance Value Index (IVI) of the weeds encountered in rice crop fields are provided in Table –2. A total of 80 weed species were recorded from 100 quadrates combining 100 field sites. The most frequent weed species is *Cynodon dactylon* (40%), followed by *Marsilea quadrifolia* (38%), *Cressa cretica* and *Cyperus rotundus* (35%), *Cyperus difformis* (32%), *Wolfia globosa* (30%) and *Echinochloa colona* (29%). *Bacopa monnieri* (4.2) is most abundant weed in rice field followed by *Ammania baccifera* (4.0), *Chromolaena odorata* (3.2), *Merremia gangetica* (3.1) and *Marsilea quadrifolia* (2.8). The Important Value Index (IVI) calculated for the individual weed species encountered in the rice crop fields *Marsilea quadrifolia* (8.4) is most important species followed by *Cynodon dactylon* (7.6),*Cressa cretica* (6.5),*Cyperus rotundus* (6.5), and *Wolfia globosa* (6.4).

Where as *Wolffia globosa* (Fig.1) was the most abundant weed in rice fields of North Costal Andhra Pradesh (Murty, 2009).
In the present study broadleaves had higher diversity in species on the rice crop fields but members of the Poaceae family dominated the rice weed community. In the terms of longevity and life forms the analysis on the life span of the weeds of rice fields in the study area revealed that 63.75 % (51species) are annuals and 36.25 % (29 species) are biannual or perennials.

Out of the 80 weed species herbs 49 (61.25%), shrubs 3 (3.75%), under shrubs 6 (7.50%), sedges 7 (8.75 %) and grasses 15 (18.75%) recorded in the study. A critical study on the flora of Andhra Pradesh (Pullaiah and Chennaiah, 1997) has revealed the presence of 715 taxa as weeds in crop fields of the state 648 known as herbaceous weeds and 284 as grasses from different agro ecosystems from Andhra Pradesh.

Table 2. Phytosociological attributes of rice weeds in Visakhapatnam district

Name of the weed	TOI	TNI	F	D	A	R.F	R.D	R.A	IVI
Aeschynomene indica	7	15	7	0.2	2.1	0.5	0.5	1.4	2.4
Alternanthera sessilis	10	24	10	0.2	2.4	0.7	0.9	1.6	3.2
Ammania baccifera	12	48	12	0.5	4	0.8	1.7	2.7	5.2
Aponogeton natans	12	24	12	0.2	2	0.8	0.9	1.3	3
Assystasia gangatica	25	32	25	0.3	1.3	1.7	1.2	0.9	3.7
Bacopa monnieri	10	42	10	0.4	4.2	0.7	1.5	2.8	5
Biophytum sensitivum	10	15	10	0.2	1.5	0.7	0.5	1	2.2
Boerhaavia erecta	28	52	28	0.5	1.9	1.9	1.9	1.2	5
Chloris barbata	12	24	12	0.2	2	0.8	0.9	1.3	3
Chromolaena odorata	15	48	15	0.5	3.2	1	1.7	2.1	4.9
Coix lacrymajobi	7	18	7	0.2	2.6	0.5	0.7	1.7	2.8
Commelina erecta	25	45	25	0.5	1.8	1.7	1.6	1.2	4.5
Commelina longifolia	23	36	23	0.4	1.6	1.6	1.3	1	3.9
Cressa cretica	35	75	35	0.8	2.1	2.4	2.7	1.4	6.5
Cyanotis cristata	17	36	17	0.4	2.1	1.2	1.3	1.4	3.9
Cynodon dactylon	40	91	40	0.9	2.3	2.8	3.3	1.5	7.6
Cyperus difformis	32	65	32	0.7	2	2.2	2.3	1.3	5.9
Cyperus rotundus	35	75	35	0.8	2.1	2.4	2.7	1.4	6.5
Dactyloctenium aegyptium	21	45	21	0.5	2.1	1.4	1.6	1.4	4.5
Dentella repens	15	25	15	0.3	1.7	1	0.9	1.1	3
Echinochloa colona	29	57	29	0.6	2	2	2.1	1.3	5.4
Echinochloa crus-galli	25	45	25	0.5	1.8	1.7	1.6	1.2	4.5
Eclipta prostrata	19	35	19	0.4	1.8	1.3	1.3	1.2	3.8
Eleusina indica	12	24	12	0.2	2	0.8	0.9	1.3	3
Eragrastis riperia	23	34	23	0.3	1.5	1.6	1.2	1	3.8
Euphorbia heterophylla	12	19	12	0.2	1.6	0.8	0.7	1.1	2.6
Euphorbia indica	12	18	12	0.2	1.5	0.8	0.7	1	2.5
Evolvulus alsinoides	10	25	10	0.3	2.5	0.7	0.9	1.7	3.3
Evolvulus nummularius	17	30	17	0.3	1.8	1.2	1.1	1.2	3.4
Fimbristylis bisumbellata	18	24	18	0.2	1.3	1.2	0.9	0.9	3
Fimbristylis cymosa	12	19	12	0.2	1.6	0.8	0.7	1.1	2.6
Fimbristylis dichotoma	15	21	15	0.2	1.4	1	0.8	0.9	2.7
Fimbristylis miliaceae	12	19	12	0.2	1.6	0.8	0.7	1.1	2.6
Gisekia pharnacoides	15	29	15	0.3	1.9	1	1	1.3	3.4
Hedyotis corymbosa	21	45	21	0.5	2.1	1.4	1.6	1.4	4.5
Hedyotis gracilis	12	18	12	0.2	1.5	0.8	0.7	1	2.5
Heliotropium curassavicum	21	35	21	0.4	1.7	1.4	1.3	1.1	3.8
Hygrophila auriculata	20	29	20	0.3	1.5	1.4	1	1	3.4
Ipomoea aquatica	12	18	12	0.2	1.5	0.8	0.7	1	2.5
Ipomoea carnia	15	21	15	0.2	1.4	1	0.8	0.9	2.7
Ischaemum indicum	20	39	20	0.4	2	1.4	1.4	1.3	4.1
Justicia procumbens	25	65	25	0.7	2.6	1.7	2.3	1.7	5.8
Lemna gibba	24	55	24	0.6	2.3	1.7	2	1.5	5.2
Leptochloa chinensis	18	29	18	0.3	1.6	1.2	1	1.1	3.4
Limnophila indica	12	25	12	0.3	2.1	0.8	0.9	1.4	3.1
Lindernia antipoda	19	25	19	0.3	1.3	1.3	0.9	0.9	3.1
Lindernia ciliata	17	31	17	0.3	1.8	1.2	1.1	1.2	3.5
Lindernia crustacea	16	28	16	0.3	1.8	1.1	1	1.2	3.3
Lindernia parviflora	15	23	15	0.2	1.5	1	0.8	1	2.9
Ludwigia adscendens	19	24	19	0.2	1.3	1.3	0.9	0.8	3
Ludwigia octovalvis	18	21	18	0.2	1.2	1.2	0.8	0.8	2.8
Ludwigia perennis	17	26	17	0.3	1.5	1.2	0.9	1	3.1
Marsilea quadrifolia	38	107	38	1.1	2.8	2.6	3.9	1.9	8.4
Melochia corchorifolia	12	24	12	0.2	2	0.8	0.9	1.3	3
Merremia gangetica	21	65	21	0.7	3.1	1.4	2.3	2.1	5.9
Merremia hederacea	18	25	18	0.3	1.4	1.2	0.9	0.9	3.1
Merremia tridentata	21	45	21	0.5	2.1	1.4	1.6	1.4	4.5
Mimosa pudica	20	25	20	0.3	1.3	1.4	0.9	0.8	3.1
Oplismenus burmani	15	25	15	0.3	1.7	1	0.9	1.1	3
Ottelia alismoides	12	18	12	0.2	1.5	0.8	0.7	1	2.5
Paspalidium flavidum	9	15	9	0.2	1.7	0.6	0.5	1.1	2.3
Paspalidium punctatum	14	27	14	0.3	1.9	1	1	1.3	3.2
Pennisetum polystachyon	15	29	15	0.3	1.9	1	1	1.3	3.4
Phyla nodiflora	25	45	25	0.5	1.8	1.7	1.6	1.2	4.5
Physalis minima	10	12	10	0.1	1.2	0.7	0.4	0.8	1.9
Polygala arvensis	12	19	12	0.2	1.6	0.8	0.7	1.1	2.6
Polygonum barbatum	12	18	12	0.2	1.5	0.8	0.7	1	2.5
Polygonum glabrum	15	19	15	0.2	1.3	1	0.7	0.8	2.6
Polygonum plebeium	11	17	11	0.2	1.5	0.8	0.6	1	2.4
Rottboellia cochinchinensis	19	24	19	0.2	1.3	1.3	0.9	0.8	3
Schoenoplectus articulatus	9	15	9	0.2	1.7	0.6	0.5	1.1	2.3
Spilanthus acmella	12	19	12	0.2	1.6	0.8	0.7	1.1	2.6
Tephrosia purpurea	25	54	25	0.5	2.2	1.7	2	1.4	5.1
Tephrosia tinctoria	14	21	14	0.2	1.5	1	0.8	1	2.7

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Tribulus terristris	25	45	25	0.5	1.8	1.7	1.6	1.2	4.5
Tridax procumbens	22	48	22	0.5	2.2	1.5	1.7	1.4	4.7
Vernonia cinerea	21	35	21	0.4	1.7	1.4	1.3	1.1	3.8
Vicia sativa	26	65	26	0.7	2.5	1.8	2.3	1.7	5.8
Wolfia globosa	30	75	30	0.8	2.5	2.1	2.7	1.7	6.4
Xanthium strumarium	25	40	25	0.4	1.6	1.7	1.4	1.1	4.2
Total	1451	2767	1451	29.1	150.9	100	100	100	300

TOI- Total occurrence of individuals; TNI-Total number of individuals; F-frequency; D- density; A-abundance; RA- Relative abundance; RF- Relative frequency; RD- Relative density; IVI- Importance Value Index

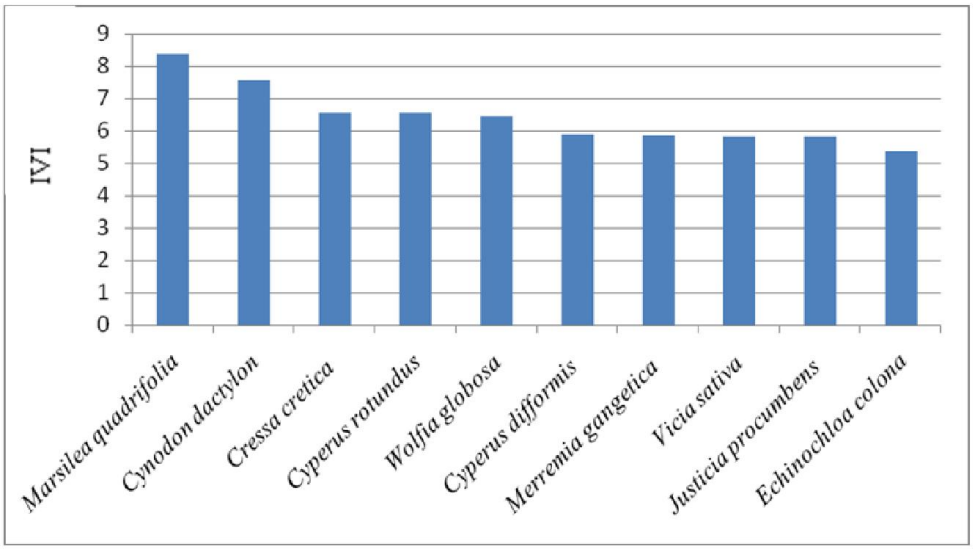

Fig.1. Top 10 important weed species in rice fields of Visakhapatnam district

The weeds like *Cyperus rotundus, Echinochloa colona*, and *Wolffia globosa* are showing the maximum infestation in rice fields of the study area. *Cyperus rotundus*, commonly called as the 'purplenut sedge', is one of the prominent weed of the present study. This weed is the native of India but has become cosmopolitan, spread over most of the tropic countries, and is treated as the world's worst weed (Holm *et al*., 1977) it attains dominance most conspicuously on irrigated lands and become serious problem in large number of irrigated crops. It is one of the weeds that appear immediately after sowing and may compete with heavily with the crop plants for nutrients and water. however some of the weeds reported from the study area having positive aspects (Padal *et al*., 2013) i.e., *Alternanthera sessilis, Bacopa monnieri, Cynodon dactylon, Cyperus rotundus, Eclipta prostrata, Mimosa pudica, Justicia procumbens, Tephrosia purpurea, Tribulus terristris, Xanthium strumarium* etc. are of medicinal importance, used in traditional medicines by local people to treat their health problems. The weeds like *Melochia corchorifolia* (leaves), *Tribulus terristris* (leaves), *Dentella repens* (Whole plant), *Eclipta prostrata* (Whole plant), *Vernonia cinerea* (leaves), *Xanthium strumarium* (leaves), *Ipomoea carnia* (leaves), *Merremia gangetica* (leaves), *Bacopa monnieri* (Whole plant), *Assystasia gangatica* (leaves), *Alternanthera sessilis* (leaves), *Polygonum plebeium* (Whole plant), *Cynodon dactylon* (leaves) and *Marsilea quadrifolia* (leaves) are used in some cooking recipies by the local people of the study area.

Conclusion

The present study was conducted as a first ever attempt from the study area to explore and identify the weeds of paddy crop. The results obtained from this study clearly established the fact that the diversity of weeds was high and significant. A thorough perusal of literature pertaining to other weed floras of different areas of India has also revealed the highest concentration of weeds in this region compared with other areas. This study will help the farmers and agriculturists of the study area to identify the weeds and thus help in planning a suitable strategy for their control as these weeds compete with paddy crop for resources and hence reduce its yield. They also affect the quality of germplasm and cause enormous loss to the farmers. The knowledge and information regarding the taxonomy, phytosociological attributes and ecology of the weeds of Visakhapatnam District will be communicated to the concerned governmental and non-governmental organizations and farmers for effective weed management and for better crop yielding. It is also helpful in designing suitable weed control technology for this area.

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