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Research Article

WEED COMPOSITION IN RICE FIELD AGROECOSYSTEM OF TERAI-DOOARS AND NORTHERN PLAIN OF WEST BENGAL, INDIA

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ABSTRACT

One of the important biological constraints to successful production of rice cultivation is the appearance and disturbance of weed. To assess the possible loss in rice cultivation due to weeds and to control them it is obligatory to study the ecological diversity and phytosociology of the weed species. The present study is to provide baseline data of weed flora for the assessment of possible trade-offs and synergies between weed biodiversity and rice production. The weeds were further classified into different categories based on their habitat and seral characteristics. In this study 84 weed species were recorded from the 35 families. The highest relative abundance allocated to the families Poaceae, Cyperaceae and Asteraceae. Most dominant weed species of the study site is *Cyperus iria* L. The study also revealed that majority of the the species are either in Sedge-Meadow Seral stage or Reed-Swamp Seral stage.

INTRODUCTION

Rice field agro ecosystem is one of the important transitional ecosystem that act as aquatic habitats for one part of the year and terrestrial habitat for another part. These fields form the largest agro ecosystem of the earth. These vast ecosystems harbor a varied range of flora and fauna. The fields undergo various seral stages when the crop cycle shifted from aquatic to terrestrial habitat and vice-versa Among the flora and fauna most of them have partial or complete negative impact on rice cultivation. The flora which are the biological constraints to successful production of rice cultivation are considered as weeds. Weed is simply defined as "a plant out of place or an unwanted plant or a plant with a negative importance or a plant that compete with human for the soil''[1].Weed surveys are useful for determining the occurrence and importance of weed species in crop production systems [2]. Presence of weeds is a serious problem of any crop field and garden. Weeds consume water intended for crops, cause water loss by seepage through root channels, transpire water, and cut water flow in irrigation ditches, leading to higher consumption by weeds and more evaporative water loss[3]. They also compete for nutrients. Some weeds act as the secondary host or alternative host for the pathogens of main crop. The level of competition between weed flora and main crop differs from location to location depending upon climatic, edaphic and management practices which are influenced by its geographical location[4]. Thus the present study was designed to investigate the phytosociological and successional aspects of weed community of rice field areas in Terai-Dooars and Northern Plain region of West Bengal, India, which is the first of its type in the region was carried out with the same backdrop. Emphasis was laid on carrying out the study of seral community.

Terai-Dooars and Northern plain region of West Bengal are two important agriculutal zones of India and famous for rice cultivation. A huge number of rice varieties are cultivated in these areas. Some of them are Swarna, Ranjit, Paijum, Kalo-nunia, Tulaipanji, Badsha-bhog, Chini-atop, Minikate, Challis-churanobboi, Jayanti etc. Weed composition and distribution patterns in rice fields are dynamic in nature. The composition of the weed flora may differ depending on location [5,6]. To formulate a appropriate weed management strategies it is obligatory to gather upto-date knowledge regarding the

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presence, composition, abundance, importance and phytosociological status of weed species [7]. Phytosociological studies are commonly used to characterized weed populations in any cropping system. The present study was undertaken to investigate the distribution and severity of weed flora prevailing in the rice cultivated zone of Terai-Dooars and Northern Plain of West Bengal, India.

MATERIAL AND METHODS

Study Sites

The present study has been carried out in several rice field areas of Terai-Dooars and Northern Plain region of West Bengal, India. The Terai and Dooars region politically constitute the plains of Darjeeling District, whole of Jalpaiguri and Alipurduar district and upper region of Cooch Behar District in West Bengal. The slope of the land is gentle, from north to south. The general height of the land is 80 to 100 m. The entire region is made up of sand, gravel and pebbles laid down by the Himalayan rivers like the Teesta, Torsa, Raidak, Jaldhaka, Sankosh and several other small rivulets. The Teesta has divided the area into two parts- the western part is known as the Terai whereas the eastern part is known as the Dooars or Duars. The area Dooars is starting from the eastern bank of river Teesta in the Jalpaiguri district and stretching up to the western bank of the river Sankosh in Alipurduar district and is spreading over a span of around 130 km of which 40 km area is running along with the Himalayan foothills. The Dooars region can be further subdivided into the Siliguri or Western Dooars, the middle or Jalpaiguri Dooars and the eastern or Alipur Dooars. Northern plain start from the south of Terai region and continues up to the left bank of the Ganges. The southern parts of the district Jalpaiguri, North Dinajpur baring some extreme northern regions, South Dinajpur, Malda, Alipurduar and southern part of Cooch Behar districts constitute this geographical region [8].

METHOD

A systematic sampling method was carried out to study the weed species in rice fields. The study was based on extensive and intensive field surveys made during different months of 2016 and 2017. The experiment was carried out in some selected rice fields where weeds were regularly eradicated. During the course of field study 60 important rice growing fields were selected which covered all the geographical sites. The weed diversity of the region was studied by quadrate method [9]. Weed sampling data was collected atleast after one month of weed eradication. Plant specimens were collected during the entire period of studies. The collected weeds were preserved in news papers, placed in proper positions and left to completely dry. After drying, all the plants were mounted on standard herbarium sheets with proper identification and taxonomy. The collected weeds were identified on the spot and in the laboratory on the basis of their natural characters with the help of identification keys, Bengal Plants [10] and other relevant literatures [5,6,11,12,13]. Herbarium Prepared from identified weeds are stored carefully. Collected plants were also grouped on the basis of its seral status. To analyse the level of diversity in weed vegetation several phytosociological parameters like frequency, Relative frequency, density and Relative density etc., were calculated. Then IVI of trees were made to determine the dominant species of the crop field.All the data both spatial and especial collected from different sources has been tabulated and analyzed separately. The data collected were used to compute several community indices.

Frequency (%): This term refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage. It is calculated by the equation:

$$\text{Frequency}(\%) = \frac{\text{No. of plot in which the species is present}}{\text{Total No. of plots sampled}} \times 100$$

Relative Frequency (%): The degree of dispersion of individual species in an area in relation to the number of all the species occurred.

$$\text{Relative Frequency }(\%) = \frac{\text{Frequency of the species}}{\text{Frequency of all the species}} \times 100$$

Density: Density is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrats is divided by the total number of quadrats studied. Density is calculated by the equation:

$$\text{Density} = \frac{\text{No. individuals of the species}}{\text{Total No. of plots sampled}}$$

Relative Density (%): Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative Density} = \frac{\text{Density of the species}}{\text{Density of all the species}} \times 100$$

Relative Dominance (%): Dominance of a species is determined by the value of the average length of root. Relative dominance is the coverage value of a species with respect to the sum of coverage of the rest of the species in the area.

$$\text{Relative dominance or Relative Height} = \frac{\text{Average length the species}}{\text{Total of averge length of all the species}} \times 100$$

Abundance: It is the study of the number of individuals of different species in the community per unit area. By quadrat method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation:

$$\text{Abundance} = \frac{\text{No. individuals of the species}}{\text{Total No. of plots in which the species is present}}$$

Importance Value Index: This index is used to determine the overall importance of each species in the community structure.In calculating this index, the percentage values of the relative frequency, relative density and relative dominance are summed up together and this value is designated as the Importance Value Index or IVI of the species.

IVI= Relative Frequency + Relative Density + Relative dominance

Species diversity (H'): Species diversity of different tree species; it was calculated using the Shannon- Weiner Index: (Shannon and Weiner, 1963).

$$(H') = -\sum [(ni / N). \ln (ni / N)]$$

Where 'ni' is the IVI of individual species and N is the total IVI of all the species [14].

Species dominance (Cd):Species dominance was calculated following Simpson: $Cd=\Sigma (ni/N)^2$,

where, ni and N are the same as those for Shannon Weiner information function [15].

Table 1 *Phytosociological* parameters of weed diversity

Sl No.	Name of The Plant	Family	D	A	F	RD	RF	RH	IVI
1	*Hygrophila auriculata* (Schumach.) Heine	Acanthaceae	0.026	0.153	17.333	0.117	2.335	2.566	5.018
2	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	0.136	1.413	9.666	0.600	1.302	1.431	3.334
3	*Amaranthus spinosus* L.	Amaranthaceae	0.223	2.576	8.666	0.981	1.167	1.283	3.432
4	*Amaranthus viridis* L.	Amaranthaceae	0.146	1.833	8.000	0.644	1.077	1.184	2.906
5	*Alternanthera sessilis* (L.) R.Br. ex DC.	Amaranthaceae	0.313	5.222	6.000	1.376	0.808	0.888	3.073
6	*Centella asiatica* (L.) Urb.	Apiaceae	0.156	4.272	3.666	0.688	0.494	0.542	1.725
7	*Lemna perpusilla Torr.*	Araceae	0.133	80.000	0.166	0.585	0.022	0.024	0.633
8	*Pistia stratiotes* L.	Araceae	0.106	4.571	2.333	0.468	0.314	0.345	1.128
9	*Colocasia esculenta* (L.) Schott.	Araceae	0.486	6.952	7.000	2.138	0.943	1.036	4.118
10	*Hydrocotyle sibthorpioides* Lam.	Araliaceae	0.453	12.363	3.666	1.992	0.494	0.542	3.028
11	*Hydrocotyle javanica Thunb.*	Araliaceae	0.363	10.900	3.333	1.596	0.449	0.493	2.539
12	*Enydra fluctuans* DC.	Asteraceae	0.090	1.285	7.000	0.395	0.943	1.036	2.374
13	*Eclipta prostrata* (L.) L.	Asteraceae	0.123	1.541	8.000	0.541	1.077	1.184	2.804
14	*Grangea maderaspatana* (L.) Poir.	Asteraceae	0.056	1.307	4.333	0.249	0.583	0.641	1.474
15	*Parthenium hysterophorus* L.	Asteraceae	0.046	0.259	18.000	0.205	2.425	2.664	5.295
16	*Ageratum conyzoides* (L.) L.	Asteraceae	0.163	1.484	11.000	0.717	1.482	1.628	3.828
17	*Ageratum houstonianum Mill.*	Asteraceae	0.053	0.571	9.333	0.234	1.257	1.381	2.873
18	*Mikania micrantha Kunth*	Asteraceae	0.390	11.700	3.333	1.713	0.449	0.493	2.656
19	*Cleome rutidosperma* DC.	Cleomaceae	0.403	3.903	10.333	1.772	1.392	1.529	4.694
20	*Cleome viscosa* L.	Cleomaceae	0.020	0.285	7.000	0.087	0.943	1.036	2.067
21	*Commelina benghalensis* L.	Commelinaceae	0.376	3.531	10.666	1.655	1.437	1.579	4.671
22	*Commelina diffusa Burm.* f.	Commelinaceae	0.606	4.439	13.666	2.665	1.841	2.023	6.530
23	*Murdannia nudiflora* (L.) Brenan	Commelinaceae	0.166	3.125	5.333	0.732	0.718	0.789	2.240
24	*Floscopa scandens Lour.*	Commelinaceae	0.013	0.160	8.333	0.058	1.122	1.233	2.415
25	*Ipomoea aquatica Forssk.*	Convolvulaceae	0.266	1.818	14.666	1.171	1.976	2.171	5.319
26	*Evolvulus nummularius* (L.) L.	Convolvulaceae	0.360	5.684	6.333	1.581	0.853	0.937	3.372
27	*Fimbristylis quinquangularis* (Vahl) Kunth	Cyperaceae	0.590	4.657	12.666	2.592	1.706	1.875	6.174
28	*Bulbostylis densa* (Wall.) Hand. - Mazz.	Cyperaceae	0.200	6.000	3.333	0.878	0.449	0.493	1.821
29	*Kyllinga brevifolia Rottb.*	Cyperaceae	0.323	5.388	6.000	1.420	0.808	0.888	3.117
30	*Schoenoplectiella juncoides* (Roxb.) Lye	Cyperaceae	0.913	5.372	17.000	4.013	2.290	2.516	8.820
31	*Cyperus iria* L.	Cyperaceae	0.070	0.230	30.333	0.307	4.087	4.490	8.885
32	*Cyperus eragrostis Lam.*	Cyperaceae	0.213	1.084	19.666	0.937	2.649	2.911	6.498
33	*Cyperus rotundus* L.	Cyperaceae	0.770	5.500	14.000	3.383	1.886	2.072	7.342
34	*Drosera burmanni Vahl*	Droseraceae	0.023	1.166	2.000	0.102	0.269	0.296	0.668
35	*Eriocaulon cinereum* R.Br.	Eriocaulaceae	0.136	5.125	2.666	0.600	0.359	0.394	1.354
36	*Desmodium heterophyllum* (Willd.)DC.	Fabaceae	0.023	0.411	5.666	0.102	0.763	0.838	1.704
37	*Desmodium triflorum* (L.) DC.	Fabaceae	0.240	5.142	4.666	1.054	0.628	0.690	2.374
38	*Aeschynomene indica* L.	Fabaceae	0.010	0.047	21.000	0.043	2.829	3.108	5.982
39	*Hydrolea zeylanica* (L.) Vahl	Hydroleaceae	0.026	0.210	12.666	0.117	1.706	1.875	3.699
40	*Hypericum japonicum* Thunb.	Hypericaceae	0.360	13.500	2.666	1.581	0.359	0.394	2.336
41	*Leucas aspera* (Willd.)Link	Lamiaceae	0.193	2.320	8.333	0.849	1.122	1.233	3.206
42	*Utricularia scandens Benj.*	Lentibulariaceae	0.463	13.900	3.333	2.036	0.449	0.493	2.978
43	*Utricularia aurea* Lour.	Lentibulariaceae	0.373	10.181	3.666	1.640	0.494	0.542	2.677
44	*Utricularia bifida* L.	Lentibulariaceae	0.273	7.454	3.666	1.201	0.494	0.542	2.237
46	*Lindernia ciliate* (Colsm) Pennell	Linderniaceae	0.293	12.571	2.333	1.288	0.314	0.345	1.948
45	*Lindernia crustacea* (L.) F.Muell	Linderniaceae	0.320	6.400	5.000	1.406	0.673	0.740	2.820
47	*Lindernia dubia* (L.) Pennell	Linderniaceae	0.340	7.285	4.666	1.494	0.628	0.690	2.813
48	*Lindernia rotundifolia* (L.) Alston	Linderniaceae	0.376	9.416	4.000	1.655	0.538	0.592	2.786
49	*Ammannia baccifera* L.	Lythraceae	0.216	2.954	7.333	0.952	0.988	1.085	3.025
50	*Melastoma malabathricum* L.	Melastomataceae	0.020	0.103	19.333	0.087	2.604	2.862	5.554
51	*Marsilea minuta* L.	Marsileaceae	0.853	25.600	3.333	3.749	0.449	0.493	4.692
52	*Marsilea quadrifolia* L.	Marsileaceae	0.780	26.000	3.000	3.427	0.404	0.444	4.275
53	*Glinus oppositifolius* (L.) Aug.DC.	Molluginaceae	0.303	4.550	6.666	1.332	0.898	0.986	3.218
54	*Nymphaea rubra Roxb.* ex Andrews	Nymphaeaceae	0.060	0.391	15.333	0.263	2.066	2.269	4.599
55	*Nymphaea pubescens* Willd.	Nymphaeaceae	0.086	0.490	17.666	0.380	2.380	2.615	5.376
56	*Ludwigia perennis* L.	Onagraceae	0.680	3.777	18.000	2.988	2.425	2.664	8.078
57	*Ludwigia adscendens* (L.) H.Hara	Onagraceae	0.033	0.277	12.000	0.146	1.616	1.776	3.539
58	*Ludwigia octovalvis* (Jacq.) P.H.Raven	Onagraceae	0.363	2.725	13.333	1.596	1.796	1.973	5.366
59	*Oxalis corniculata* L.	Oxalidaceae	0.563	14.083	4.000	2.475	0.538	0.592	3.606
60	*Phyllanthus fraternus* G.L. Webster	Phyllanthaceae	0.093	2.000	4.666	0.410	0.628	0.690	1.729
61	*Scoparia dulcis* L.	Plantaginaceae	0.223	3.190	7.000	0.981	0.943	1.036	2.960
62	*Auxonopus compressus* (Swartz.) P.Beauv.	Poaceae	0.693	9.043	7.666	3.046	1.033	1.134	5.214
63	*Eleusine indica* (L.) Gaertn.	Poaceae	0.180	2.250	8.000	0.790	1.077	1.184	3.053
64	*Digitaria sanguinalis* (L.) Scop.	Poaceae	0.296	2.696	11.000	1.303	1.482	1.628	4.414
65	*Echinochloa colona* (L.) Link	Poaceae	0.190	1.295	14.666	0.834	1.976	2.171	4.982
66	*Imperata cylindrica* (L.) Raeusch.	Poaceae	0.060	0.461	13.000	0.263	1.751	1.924	3.939
67	*Oplismenus burmanni* (Retz.) P.Beauv.	Poaceae	0.503	7.190	7.000	2.211	0.943	1.036	4.191
68	*Cynodon dactylon* (L.) Pers.	Poaceae	0.926	16.352	5.666	4.072	0.763	0.838	5.674
69	*Eragrostis unioloides* (Retz.) Nees ex Steud.	Poaceae	0.650	10.833	6.000	2.856	0.808	0.888	4.552
70	*Digitaria bicornis* (Lam.)Roemer & J.A. Schultes ex. Loud	Poaceae	0.450	5.869	7.666	1.977	1.033	1.134	4.145
71	*Saccharum spontaneum* L.	Poaceae	0.160	0.366	43.666	0.703	5.883	6.464	13.051
72	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	0.096	1.318	7.333	0.424	0.988	1.085	2.498
73	*Persicaria hydropiper* (L.) Delarbre	Polygonaceae	0.206	1.441	14.333	0.908	1.931	2.121	4.961
74	*Monochoria hastata* (L.) Solms	Pontederiaceae	0.100	0.967	10.333	0.439	1.392	1.529	3.361
75	*Monochoria vaginalis* (Burm.f.) C.Presl	Pontederiaceae	0.040	0.666	6.000	0.175	0.808	0.888	1.872
76	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	0.086	1.238	7.000	0.380	0.943	1.036	2.360
77	*Ceratopteris thalictroides* (L.) Brongn.	Pteridaceae	0.170	1.888	9.000	0.747	1.212	1.332	3.292
78	*Ranunculus sceleratus* L.	Ranunculaceae	0.053	0.842	6.333	0.234	0.853	0.937	2.025
79	*Spermacoce alata Aubl.*	Rubiaceae	0.256	2.961	8.666	1.127	1.167	1.283	3.578
80	*Dentella repens* (L.)J.R.Forst. & G.Forst	Rubiaceae	0.390	9.000	4.333	1.713	0.583	0.641	2.939
81	*Oldenlandia diffusa* (Willd.) Roxb.	Rubiaceae	0.326	7.538	4.333	1.435	0.583	0.641	2.660
82	*Azolla pinnata* R. Br.	Salviniaceae	0.106	8.000	1.333	0.468	0.179	0.197	0.845
83	*Salvinia natans* (L.) All.	Salviniaceae	0.106	3.555	3.000	0.468	0.404	0.444	1.317
84	*Pouzolzia zeylanica* (L.) Benn.	Urticaceae	0.213	2.782	7.666	0.937	1.033	1.134	3.105

A= Abundance, D= Density, Fr= Frequency, BA= Basal Area, RD=Relative Density, RF= Relative Frequency, RH= Relative Height, IVI= Importance Value Index

Equitability of evenness (e): Equitability of evenness refers to the degree of relative dominance of each species in that area. It was calculated as: Evenness (e) = H'/log S
where, H'= Shannon index, S = number of species [16].

Species richness (D): Species richness was determined by Margalef index (Margalef 1968) as:
D=(S-1)/ln N.
S = number of species. N= total number of individuals . [17]

Menhinick's index (D_{mm}): Menhinick's index (Whittaker 1977) is expressed as D_{mm}=S/ N, where N is the number of individuals in the sample and S is the species number. [18]

Equitability Index: The Shannon's equitability Index (Lloyd and Ghelard, 1964) is expressed as (EH)=H/Hmax = H/ln S [19]

Berger-Parker Dominance Index: The Berger-Parker Dominance Index is a simple measure of the numerical importance of the most abundant species and is expressed as d= Nmax/N.

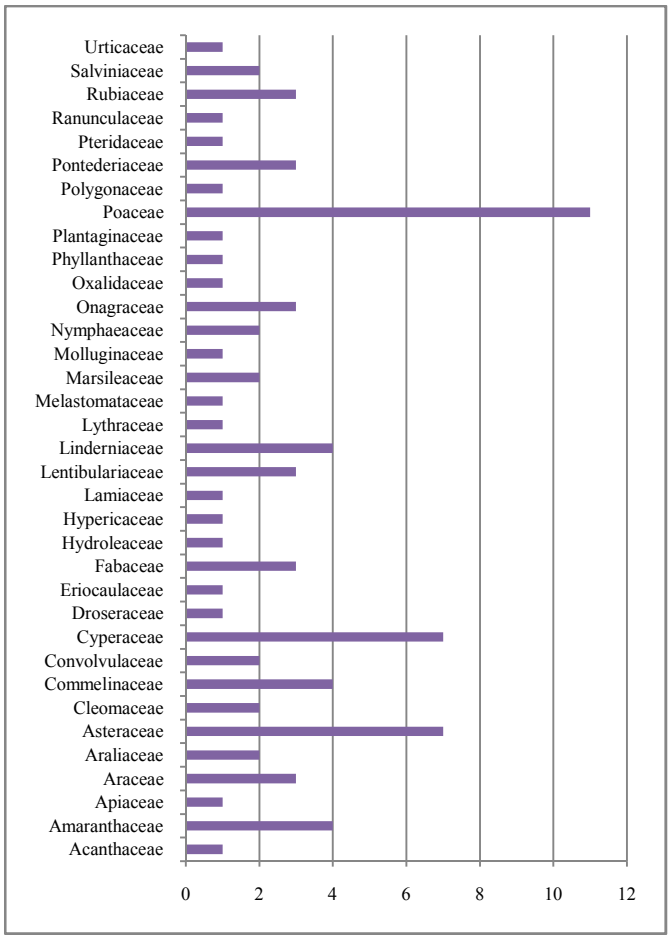
N_{max} is the number of individuals in the most abundant species and N is the total number of individuals in the sample. The increase in the value of reciprocal of Berger-Parker Dominance Index reflects the increase in diversity and a reduction in dominance [20].

RESULT AND DISCUSSION

During exploration, 84 species belonging to 35 families were collected, identified and documented. The highest relative abundance allocated to respectively families of Poaceae, Cyperaceae and Asteraceae. Out of the weed species highest IVI was recorded for *Cyperus iria* L. (8.885). IVI was also good for *Schoenoplectiella juncoides* (Roxb.) Lye (8.820), *Ludwigia perennis* L. (8.078), *Cyperus rotundus* L. (7.342).IVI was lowest for *Lemna perpusilla* Torr. (0.633) and *Drosera burmanni* Vahl (0.668). Among these weeds most of them are aquatic or semi aquatic. Most of them are either in Sedge-Meadow Seral stage (34.523%) or Reed-Swamp Seral stage (29.761%).

Table 2 Community indices of weed Community

Sl No.	Name of The Plant	Species Diversity (H')	Species Dominance (Cd)	Equitability of Evenness (e)
1	*Hygrophila auriculata* (Schumach.) Heine	0.066776	0.000262	0.059746
2	*Alternanthera philoxeroides* (Mart.) Griseb.	0.048762	0.000115	0.039691
3	*Amaranthus spinosus* L.	0.049875	0.000122	0.040858
4	*Amaranthus viridis* L.	0.043799	0.000086	0.034603
5	*Alternanthera sessilis* (L.) R.Br. ex DC.	0.045759	0.000098	0.036590
6	*Centella asiatica* (L.) Urb.	0.028901	0.000030	0.020539
7	*Lemna perpusilla* Torr.	0.012653	0.000004	0.007536
8	*Pistia stratiotes* L.	0.020451	0.000013	0.013435
9	*Colocasia esculenta* (L.) Schott.	0.057421	0.000176	0.049024
10	*Hydrocotyle sibthorpioides* Lam.	0.045238	0.000095	0.036058
11	*Hydrocotyle javanica* Thunb.	0.039368	0.000067	0.030228
12	*Enydra fluctuans* DC.	0.037334	0.000058	0.028273
13	*Eclipta prostrata* (L.) L.	0.042579	0.000081	0.033383
14	*Grangea maderaspatana* (L.) Poir.	0.025446	0.000022	0.017552
15	*Parthenium hysterophorus* L.	0.069538	0.000292	0.063036
16	*Ageratum conyzoides* (L.) L.	0.054283	0.000152	0.045575
17	*Ageratum houstonianum* Mill.	0.043406	0.000086	0.034209
18	*Mikania micrantha* Kunth	0.040799	0.000073	0.031623
19	*Cleome rutidosperma* DC.	0.063474	0.000229	0.055886
20	*Cleome viscosa* L.	0.033424	0.000045	0.024611
21	*Commelina benghalensis* L.	0.063238	0.000227	0.055613
22	*Commelina diffusa* Burm. f.	0.081343	0.000444	0.077744
23	*Murdannia nudiflora* (L.) Brenan	0.035643	0.000052	0.026673
24	*Floscopa scandens* Lour.	0.037835	0.000060	0.028750
25	*Ipomoea aquatica* Forssk.	0.069777	0.000294	0.063324
26	*Evolvulus nummularius* (L.) L.	0.049204	0.000118	0.040153
27	*Fimbristylis quinquangularis* (Vahl) Kunth	0.078025	0.000397	0.073506
28	*Bulbostylis densa* (Wall.) Hand. - Mazz.	0.030193	0.000034	0.021684
29	*Kyllinga brevifolia* Rottb.	0.046270	0.000101	0.037113
30	*Schoenoplectiella juncoides* (Roxb.) Lye	0.101312	0.000810	0.105008
31	*Cyperus iria* L.	0.101844	0.000822	0.105776
32	*Cyperus eragrostis* Lam.	0.081050	0.000439	0.077366
33	*Cyperus rotundus* L.	0.088680	0.000561	0.087411
34	*Drosera burmanni* Vahl	0.013237	0.000004	0.007953
35	*Eriocaulon cinereum* R.Br.	0.023749	0.000019	0.016126
36	*Desmodium heterophyllum* (Willd.)DC.	0.028626	0.000030	0.020297
37	*Desmodium triflorum* (L.) DC.	0.037326	0.000005	0.028265
38	*Aeschynomene indica* L.	0.076207	0.000372	0.071217
39	*Hydrolea zeylanica* (L.) Vahl	0.052860	0.000142	0.044036
40	*Hypericum japonicum* Thunb.	0.036847	0.000056	0.027809
41	*Leucas aspera* (Willd.)Link	0.047295	0.000107	0.038167
42	*Utricularia scandens* Benj.	0.044647	0.000009	0.035459
43	*Utricularia aurea* Lour.	0.041053	0.000007	0.031873
44	*Utricularia bifida* L.	0.035610	0.000052	0.026642
46	*Lindernia ciliate* (Colsm) Pennell	0.031879	0.000039	0.023200
45	*Lindernia crustacea* (L.) F.Muell	0.042768	0.000082	0.033572
47	*Lindernia dubia* (L.) Pennell	0.042692	0.000082	0.033496
48	*Lindernia rotundifolia* (L.) Alston	0.042365	0.000080	0.033170
49	*Ammannia baccifera* L.	0.045201	0.000095	0.036021
50	*Melastoma malabathricum* L.	0.072092	0.000321	0.066130
51	*Marsilea minuta* L.	0.063453	0.000229	0.055862
52	*Marsilea quadrifolia* L.	0.059104	0.000190	0.050903
53	*Glinus oppositifolius* (L.) Aug.DC.	0.047434	0.000107	0.038311
54	*Nymphaea rubra* Roxb. ex Andrews	0.062495	0.000220	0.054757
55	*Nymphaea pubescens* Willd.	0.070343	0.000301	0.064007
56	*Ludwigia perennis* L.	0.095075	0.000679	0.096168
57	*Ludwigia adscendens* (L.) H.Hara	0.051087	0.000130	0.042140
58	*Ludwigia octovalvis* (Jacq.) P.H.Raven	0.070249	0.000299	0.063892
59	*Oxalis corniculata* L.	0.051833	0.000135	0.042935
60	*Phyllanthus fraternus* G.L. Webster	0.028962	0.000031	0.020592
61	*Scoparia dulcis* L.	0.044438	0.000091	0.035248
62	*Auxonopus compressus* (Swartz.) P.Beauv.	0.068740	0.000283	0.062079
63	*Eleusine indica* (L.) Gaertn.	0.045521	0.000097	0.036347
64	*Digitaria sanguinalis* (L.) Scop.	0.060562	0.000202	0.052550
65	*Echinochloa colona* (L.) Link	0.066410	0.000258	0.059313
66	*Imperata cylindrica* (L.) Raeusch.	0.055498	0.000161	0.046902
67	*Oplismenus burmanni* (Retz.) P.Beauv.	0.058204	0.000182	0.049895
68	*Cynodon dactylon* (L.) Pers.	0.073253	0.000335	0.067553
69	*Eragrostis unioloides* (Retz.) Nees ex Steud.	0.062011	0.000215	0.054202
70	*Digitaria bicornis* (Lam.)Roemer & J.A. Schultes ex. Loud	0.057714	0.000178	0.049350
71	*Saccharum spontaneum* L.	0.133400	0.001773	0.155370
72	*Dactyloctenium aegyptium* (L.) Willd.	0.038868	0.000065	0.029744
73	*Persicaria hydropiper* (L.) Delarbre	0.066197	0.000256	0.059063
74	*Monochoria hastata* (L.) Solms	0.049074	0.000117	0.040017
75	*Monochoria vaginalis* (Burm.f.) C.Presl	0.030872	0.000036	0.022291
76	*Eichhornia crassipes* (Mart.) Solms	0.037151	0.000058	0.028098
77	*Ceratopteris thalictroides* (L.) Brongn.	0.048282	0.000112	0.039191
78	*Ranunculus sceleratus* L.	0.032879	0.000042	0.024110
79	*Spermacoce alata* Aubl.	0.051521	0.000133	0.042602
80	*Dentella repens* (L.)J.R.Forst. & G.Forst	0.044182	0.000089	0.034989
81	*Oldenlandia diffusa* (Willd.) Roxb.	0.040853	0.000073	0.031676
82	*Azolla pinnata* R. Br.	0.016114	0.000007	0.010068
83	*Salvinia natans* (L.) All.	0.023210	0.000018	0.015679
84	*Pouzolzia zeylanica* (L.) Benn.	0.046130	0.000100	0.036969

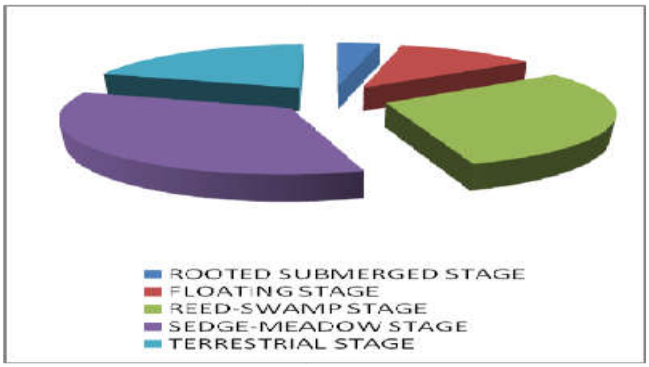


Graph 1 Family status of weed composition of Rice field

Table 3 Status of seral stages of the weed composition of Rice field

SL. No.	Name of the Plant	Seral Stage
1	*Hygrophila auriculata* (Schumach.) Heine	Reed-swamp
2	*Alternanthera philoxeroides* (Mart.) Griseb.	Reed-swamp
3	*Amaranthus spinosus* L.	Terrestrial
4	*Amaranthus viridis* L.	Terrestrial
5	*Alternanthera sessilis* (L.) R.Br. ex DC.	Sedge-meadow
6	*Centella asiatica* (L.) Urb.	Sedge-meadow

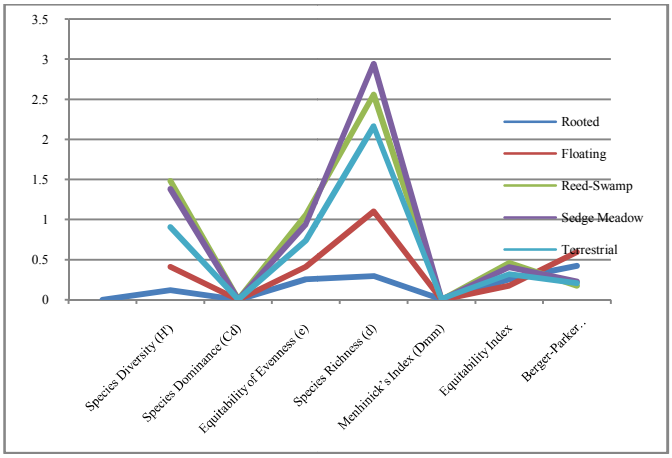
7	*Lemna perpusilla* Torr.	Floating
8	*Pistia stratiotes* L.	Floating
9	*Colocasia esculenta* (L.) Schott.	Reed-swamp
10	*Hydrocotyle sibthorpioides* Lam.	Sedge-meadow
11	*Hydrocotyle javanica* Thunb.	Sedge-meadow
12	*Enydra fluctuans* DC.	Reed-swamp
13	*Eclipta prostrata* (L.) L.	Terrestrial
14	*Grangea maderaspatana* (L.) Poir.	Sedge-meadow
15	*Parthenium hysterophorus* L.	Terrestrial
16	*Ageratum conyzoides* (L.) L.	Terrestrial
17	*Ageratum houstonianum* Mill.	Terrestrial
18	*Mikania micrantha* Kunth	Terrestrial
19	*Cleome rutidosperma* DC.	Terrestrial
20	*Cleome viscosa* L.	Terrestrial
21	*Commelina benghalensis* L.	Reed-swamp
22	*Commelina diffusa* Burm. f.	Reed-swamp
23	*Murdannia nudiflora* (L.) Brenan	Sedge-meadow
24	*Floscopa scandens* Lour.	Reed-swamp
25	*Ipomoea aquatica* Forssk.	Floating
26	*Evolvulus nummularius* (L.) L.	Sedge-meadow
27	*Fimbristylis quinquangularis* (Vahl) Kunth	Sedge-meadow
28	*Bulbostylis densa* (Wall.) Hand. - Mazz.	Reed-swamp
29	*Kyllinga brevifolia* Rottb.	Sedge-meadow
30	*Schoenoplectiella juncoides* (Roxb.) Lye	Reed-swamp
31	*Cyperus iria* L.	Reed-swamp
32	*Cyperus eragrostis* Lam.	Reed-swamp
33	*Cyperus rotundus* L.	Reed-swamp
34	*Drosera burmanni* Vahl	Sedge-meadow
35	*Eriocaulon cinereum* R.Br.	Reed-swamp
36	*Desmodium heterophyllum* (Willd.)DC.	Sedge-meadow
37	*Desmodium triflorum* (L.) DC.	Sedge-meadow
38	*Aeschynomene indica* L.	Reed-swamp
39	*Hydrolea zeylanica* (L.) Vahl	Reed-swamp
40	*Hypericum japonicum* Thunb.	Sedge-meadow
41	*Leucas aspera* (Willd.)Link	Terrestrial
42	*Utricularia scandens* Benj.	Rooted submerged
43	*Utricularia aurea* Lour.	Rooted submerged
44	*Utricularia bifida* L.	Rooted submerged
45	*Lindernia ciliate* (Colsm) Pennell	Sedge-meadow
46	*Lindernia crustacea* (L.) F.Muell	Sedge-meadow
47	*Lindernia dubia* (L.) Pennell	Reed-swamp
48	*Lindernia rotundifolia* (L.) Alston	Reed-swamp
49	*Ammannia baccifera* L.	Reed-swamp
50	*Melastoma malabathricum* L.	Terrestrial
51	*Marsilea minuta* L.	Reed-swamp
52	*Marsilea quadrifolia* L.	Reed-swamp
53	*Glinus oppositifolius* (L.) Aug.DC.	Sedge-meadow
54	*Nymphaea rubra* Roxb. ex Andrews	Floating
55	*Nymphaea pubescens* Willd.	Floating
56	*Ludwigia perennis* L.	Reed-swamp
57	*Ludwigia adscendens* (L.) H.Hara	Floating
58	*Ludwigia octovalvis* (Jacq.) P.H.Raven	Reed-swamp
59	*Oxalis corniculata* L.	Sedge-meadow
60	*Phyllanthus fraternus* G.L. Webster	Terrestrial
61	*Scoparia dulcis* L.	Terrestrial
62	*Auxonopus compressus* (Swartz.) P.Beauv.	Sedge-meadow
63	*Eleusine indica* (L.) Gaertn.	Sedge-meadow
64	*Digitaria sanguinalis* (L.) Scop.	Sedge-meadow
65	*Echinochloa colona* (L.) Link	Sedge-meadow
66	*Imperata cylindrica* (L.) Raeusch.	Sedge-meadow
67	*Oplismenus burmanni* (Retz.) P.Beauv.	Sedge-meadow
68	*Cynodon dactylon* (L.) Pers.	Sedge-meadow
69	*Eragrostis unioloides* (Retz.) Nees ex Steud.	Sedge-meadow
70	*Digitaria bicornis* (Lam.)Roemer & J.A. Schultes ex. Loud	Sedge-meadow
71	*Saccharum spontaneum* L.	Terrestrial
72	*Dactyloctenium aegyptium* (L.) Willd.	Sedge-meadow
73	*Persicaria hydropiper* (L.) Delarbre	Sedge-meadow
74	*Monochoria hastata* (L.) Solms	Reed-swamp
75	*Monochoria vaginalis* (Burm.f.) C.Presl	Reed-swamp
76	*Eichhornia crassipes* (Mart.) Solms	Floating
77	*Ceratopteris thalictroides* (L.) Brongn.	Floating
78	*Ranunculus sceleratus* L.	Reed-swamp
79	*Spermacoce alata* Aubl.	Terrestrial
80	*Dentella repens* (L.)J.R.Forst. & G.Forst	Sedge-meadow
81	*Oldenlandia diffusa* (Willd.) Roxb.	Terrestrial
82	*Azolla pinnata* R. Br.	Floating
83	*Salvinia natans* (L.) All.	Floating
84	*Pouzolzia zeylanica* (L.) Benn.	Terrestrial



Graph 2 Status of seral stages of the weed composition of Rice field

Table 4 Variation of community indices of weed composition based on seral stages

Community indices Value	Rooted Submerged	Floating	Reed-Swamp	Sedge Meadow	Terrestrial
Species Diversity (H')	0.121310	0.411563	1.479568	1.380964	0.905868
Species Dominance (Cd)	0.000068	0.001157	0.006390	0.003759	0.003795
Equitability of Evenness (e)	0.254254	0.411563	1.058391	0.944314	0.736209
Species Richness (d)	0.297026	1.103141	2.557556	2.941575	2.163054
Menhinick's Index (D_{mn})	0.003571	0.002862	0.002101	0.002130	0.010423
Equitability Index	0.254254	0.178739	0.459653	0.410110	0.319731
Berger-Parker Dominance Index	0.423809	0.595476	0.177706	0.231413	0.209074

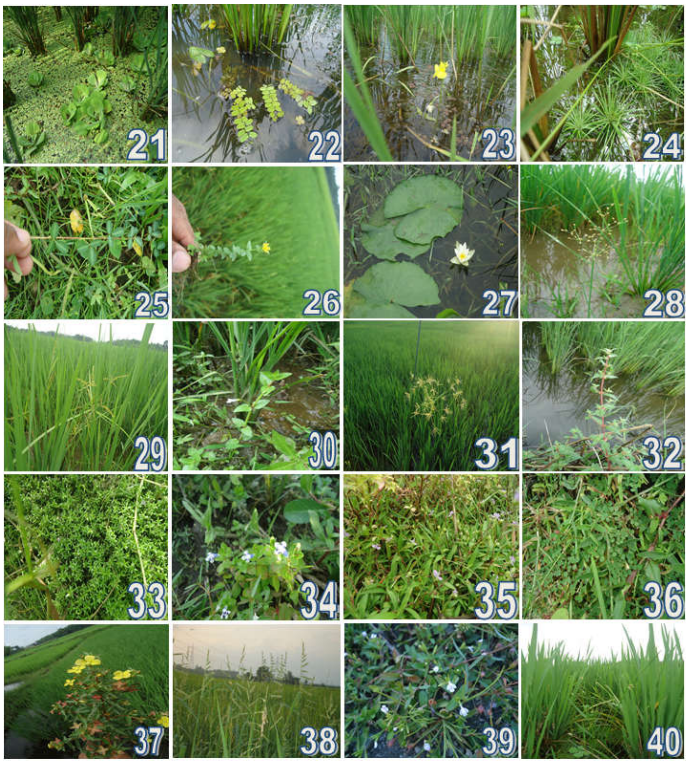


Graph 3 Variation of community indices of weed composition based on seral stages

CONCLUSION

The study was a preliminary attempt to gather information on the ecological and phytosociological information of weed flora of rice field agroecosystem of Northern part of the West Bengal. The investigation revealed the presence of 84 species belonging to 35 families. Among the weeds *Cyperus iria* L. was recorded as most frequent and *Lemna perpusilla* Torr. was recorded as most abundant species. However highest IVI was recorded for *Cyperus iria* L. IVI is also good for the members of Poaceae, Cyperaceae and Asteraceae. As the agroecosystem is a kind of transition ecosystem between aquatic and terrestrial habitat, a number of seral stages are observed. The seral stages are Rooted Submerged Stage, Floating stage, Reed-Swamp Stage, Sedge-Meadow Stage and Terrestrial Stage. Among the weed composition 34.523% are the representative of Sedge-Meadow Stage and only 3.571% are the representative of Rooted Submerged stage. Among the seral stages highest density is found for Sedge-Meadow Stage.

1. Monochoria hastata (L.) Solms, *2. Colocasia esculenta* (L.) Schott., *3. Monochoria vaginalis* (Burm.f.) C.Presl, *4. Spermacoce alata* Aubl., *5. Cyperus eragrostis* Lam., *6. Aeschynomene indica* L., *7. Ageratum conyzoides* (L.) L., *8. Pistia stratiotes* L., *9. Alternanthera sessilis* (L.) R.Br. ex DC., *10. Commelina diffusa* Burm. f., *11. Ceratopteris thalictroides* (L.) Brongn., *12. Scoparia dulcis* L., *13. Ludwigia perennis* L., *14. Amaranthus spinosus* L., *15. Cynodon dactylon* (L.) Pers., *16. Marsilea quadrifolia* L. , *17. Ludwigia adscendens* (L.) H.Hara, *18. Azolla pinnata* R. Br., *19. Eichhornia crassipes* (Mart.) Solms, *20. Glinus oppositifolius* (L.) Aug.DC.



21. Lemna perpusilla Torr., *22. Salvinia natans* (L) All., *23. Utricularia scandens* Benj., *24. Eriocaulon cinereum* R.Br., *25. Desmodium heterophyllum* (Willd.)DC., *26. Hypericum japonicum* Thunb., *27. Nymphaea pubescens* Willd., *28. Fimbristylis quinquangularis (Vahl) Kunth., 29. Cyperus iria* L., *30. Lindernia dubia (L) Pennell*, *31. Cyperus rotundus* L., *32. Pouzolzia zeylanica* (L.) Benn., *33. Dentella repens* (L.)J.R.Forst. & G.Forst., *34. Lindernia rotundifolia* (L.) Alston., *35. Murdannia nudiflora* (L.) Brenan, *36. Desmodium triflorum* (L.) DC., *37. Ludwigia octovalvis* (Jacq.) P.H.Raven, *38. Echinochloa colona* (L.) Link, *39. Lindernia ciliate* (Colsm) Pennell, *40. Schoenoplectiella juncoides* (Roxb.) Lye

But the dominant species *Cyperus iria* L., *Cyperus eragrostis* Lam., *Cyperus rotundus* L. etc belong to Reed-Swamp Stage. Most frequent species *Lemna perpusilla* Torr. belong to Floating stage. It can be concluded that species diversity is being regulated by ecological factors like community stability and evolutionary time as heterogeneity of both micro and macro environment affects the diversification among different communities. Species diversity and Species dominance indices marginally varied for the weeds of different seral stages. As changing pattern of field condition put pressure on the weed community of the rice field, different methods should be applied for control of the weed species in Rice field.

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