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Studies on weed diversity and its associated phytosociology under direct dry seeded rice systems

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ABSTRACT

Chhattisgarh is commonly known as Bowl of rice where rice is grown as monocrop in the entire state whether soil is bhata, matasi, kanhar or black soil. Present study is based on the study of biodiversity of weeds under Direct Dry Seeded Rice Systems in Koria District (C.G.) Study was conducted to assess the phytosociological studies of weed species in paddy field at Baikunthpur, Koriya district, Chattisgarh. A total of 43 genera and 9 families of Dicotyledonae and 3 families of monocots and 1 Pteridophytes was also observed and 43 weed species were identified Ratio of Sedges: (Grasses:Broad-leaved weeds was calculated as 9:12:18 Ratio) under direct dry seeded rice systems. The results obtained indicated that *Echinochloa colona*, *Cyperus iria* and *Cynodon dactylon* were the most frequent in 2007; *E. colona* and *C. iria* were the most frequent in 2008 and 2009. The importance value index (IVI) revealed that the most important weeds within the community were Poaceae and Cyperaceae. Out of 12 angiosperm families the predominance was shown by monocot families Cyperaceae and Poaceae having and weed species, respectively. The pteridophyta family Marsileaceae was represented by 1 weed species.

Keywords: Weed, Paddy cropping system, Diversity, Koriya-Chattisgarh.

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INTRODUCTION

Agriculture has been a forefront agenda at national and international level for food security and management of natural resources. Cereals are the most important part of our diet throughout the world and thus, play major role in our food security. Crop paddy (*Oryza sativa* L.) has been an important crop which is extensively grown in tropical and subtropical regions of the world. It is cultivated in area of 44.0 million hectares with an annual production of 104.3 million tons in India (GOI 2012). Its production has been found to be distributed as 91.5 million tons in kharif and 12.8 million tons in rabi season. However, its productivity in India is very low (2.37 t ha^{-1}) as compared to other rice growing countries like Japan (6.35 t ha^{-1}), Australia (6.22 t ha^{-1}), Spain (6.16 t ha^{-1}), Egypt (5.0 t ha^{-1}) and China (5.2 t ha^{-1}). There are several reasons for its low productivity but the losses due to weeds are one of the most important.

Paddy is one of the most important food crops of the world and 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 branoil, 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). 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). The weeds that grow along with paddy crop results in low agricultural output. They are the major barriers to rice production because of their ability to compete for CO_2, space, moisture, sunlight and nutrients. Weedy crop sometimes leads to complete failure (Singh et al 2005). Out of total losses due to various biotic factors weeds are known to account for one third (Rao and Nagamani 2007). It has been observed that grain yield in paddy is drastically reduced if it is not de weeded at early stage of growth.

Biogeographically, Chhattisgarh state falls in Deccan bio-region comprising representative fauna of central India. Chhattisgarh used to produce over seventy percent of the total paddy production in the state. Apart from paddy, cereals like maize, Kodo-kutki and other small millets, pulses like Tur and Kulthi and oilseeds like groundnut, soya bean, Niger and sunflower are also grown. Koriya exhibits a very high temperature and assumes ecological importance for an extensive survey of cultivated fields, especially paddy crop. Rice is the first important crop of this area. In Chhattisgarh, rice is a widely grown crop. The type of rice culture used by a common farmer is generally "dry seeded". The dry seeded rice suffers a lot by heavy weed infestations. There-fore, the management of weeds in dry seeded rice was thought as a must. Other aspects, such as, phytosociology, phenology, ecology and reciprocal relations of direct seeded rice field - weeds and crop needs to be studied as thoroughly as possible. Direct-seeded rice suffers more by weed infestation than the transplanted rice.

Apart from the various traditional methods of weed control, crop suffers a lot by weeds. The extent of damage depends upon the nature of weeds, their density, dominance, ecological success and the association with the crops and other biotic and edaphic factors. It is, therefore, necessary to make a detailed survey of weeds in crop fields, their distribution, and relative occurrence in specific crops. Therefore, there is a great need of research aiming at prevention of loss of yield due to weeds in direct-seeded rice and at management of weeds by most economic and feasible method. These objectives can be achieved through a better understanding of biology of different weeds infesting direct-seeded rice fields.

MATERIAL AND METHODS

Methodology. The present study deals with major weeds of paddy fields of Shivpur, Tilpand and Itga, Rakiya, Jamgahna under Baikunthpur block of Koriya district (C.G). The study was based on extensive and intensive fields surveys during the peak period of weed growth during three successive cropping seasons from 2007-2009. Frequent field trips were made twice a month in each site for collection of weed species.

During this course interviews were conducted from farmers and agriculturalists of each site about seasonal weed species and important notes on flowering and fruiting seasons of weeds were reported. The collected weed plants were pressed, dried, preserved and properly identified with the help of available literature and monographs by Sharma and Kachroo (1983), Swami and Gupta (1998), Kaul (1986) and confirmed from the authentic regional herbaria at Botanical Survey of India.

Quadrat and phytosociological studies. Quadrats of 1 m x 1 m were laid in the agricultural fields to quantify various weed species. The size of the quadrat used in this study was decided based on the species area curve method following Misra (1968).The structure and composition of vegetation in the agricultural fields have been compared in terms of frequency, density, abundance, and basal area of major species. Importance Value Index (IVI = relative frequency + relative density + relative dominance) and species diversity index (H' = pi ln pi; where, pi = ni/N;

and ni = abundance of each species, N = total abundance of all species) were derived from the primary data separately for each layer following Misra (1968) and Shannon and Weaver (1963), respectively. Berger and Parker Index (DBP = Nmax / N, where Nmax = the number of individuals in the most species and N = the total number of all individuals in all species) were weighted toward the abundance of the commonest species. For any information-statistics index, the maximum diversity of a community is found when all species are equally abundant. Community's actual diversity is measured by the formula: Evenness (E) = H / Hmax. Rank Abundance diagrams visually describe the allocation of individuals to species in communities.

The following formulae were used to compute different phytosociological parameters:

$$\% \text{ Frequency} = \frac{\text{Total no. quadrats in which the species occurred}}{\text{Total no. of quadrate studied}} \times 100$$

$$\text{Density} = \frac{\text{Total no. individuals of a species in all the quadrats}}{\text{Total no. of quadrate studied}} \times 100$$

$$\text{Abundance} = \frac{\text{Total no. of individuals of the species in all the quadrates}}{\text{Total no. of quadrate in which the species occurred}}$$

$$\text{Relative Frequency (RF)} = \frac{\text{Total no. of occurrence of a species in all the quadrates}}{\text{Total no. of occurrence of all species in all quadrates}} \times 100$$

$$\text{Relative Density (RD)} = \frac{\text{Density of a species in all the quadrates}}{\text{Total density of all species in all quadrates}} \times 100$$

$$\text{Relative Dominance (R.Dom.)} = \frac{\text{Total basal cover of each species in all quadrats}}{\text{Total basal cover of all species in all quadrats}} \times 100$$

$$\text{IVI} = \text{Relative frequency} + \text{Relative density} + \text{Relative dominance}$$

RESULTS

Phytosociological study of plant/weed, which provide knowledge of the dynamics and relative importance of species in a particular phytosociety or across phytosocieties assume enough relevance in crop-weed ecosystem. It gives an appraisal of species through quantitative characters which allow effective weed management decision. From the results it appears that the total number of individual weeds (TNI) vary among the different species.

The variable rate of frequency class distribution of weed flora of paddy fields of Baikunthpur block may be explained by a common biological explanation pattern which implies most dominant species appeared to colonize a new area appropriates a fraction of the available resources and by competitive interaction, preempts that fraction. The second species then preempts a similar fraction of the remaining resource and so on with further colonists. Data presented in Figure 1 reveals the overall frequency distribution of the studied weed flora of the paddy fields of Baikunthpur block. The frequency value ranged between 1-74%.

Data presented in Figure 1 represents the frequency of occurrence of different weed species under the prevailing environmental set up. The results reveal that *Echinochloa colona*, *Cyperus iria* and *Cynodon dactylon* showing 74%, 50% and 39% frequency and *Marsillia minuta* (33%), *Cyperus flavidus* (33%), *Paspalum paspaloides* (33%) and *Saccharum spontanaeum* (41%) were more frequent in occurrence. The rarest of occurrence were recorded by *Alternanthera sessilis* and *Achyranthes aspera* representing only 1% of frequency values among the various studied weed flora.

Figure 2 represents the density value of the observed weed species in Baikunthpur block. The density value ranges between 0.04 and 3.3. Higher density values were recorded by *E. colona*, *C. iria*, *Eclipta prostrate* and *C. flavidus*. Highest and lowest density value were recorded by *E. colona* and *Fimbristylis littoralis*. Most of the plant species reflecting lower density values indicating single plant dominated community structure of the weed flora of the paddy field of Baikunthpur block (Figure 1) Therefore *E. colona*, *C. iria*, *E. prostrate* and *C. flavidus* can be considered as the dominant weed flora among the weed community prevailing over the paddy fields of Baikunthpur block.

Another important biodiversity indicator is the relative (proportional) abundance or degree of dominance of individuals among different species. This usually referred to as evenness or equitability and measures the extent to which species are equally represented in a community. There exists a strong correlation between structural diversity and species data pertaining to Figure 3 reveals higher relative abundance for *Cyperus haspan* (3.75), 2.60 in *C. iria*, 2.13 in *E. colona*, 3.18 in *Ageratum conyzoides* and 3.00 in *Ammannia baccifera*, *Digitaria sanguinalis* and *E. prostrata*. Species showing very less abundance were *Andropogon pumilis*, *A. aspera*, *Eragrostis pilosa*, *Ipomoea aquatica*, *Justicia simplex*, *Parthenium hysterophorus*, *Paspalum paspaloides*, *Polygonum plebejum* and *Sida cordifolia*.

The relative frequency distribution values represented in Table 1 reflects significant level of variation among the different observed weed species. The relative frequency distribution represented in table1 reflects lower values .This therefore indicates that relative proportion of occurrence of species to each other is very low.

The relative density data presented in Table 1 reflects significant level of variation in the relative density value among the 43 weed species of Baikunthpur block of Korea District. Relative density value was found to be highest for *C. flavidus* which clearly reflects the single plant dominating feature among the weed community of the paddy fields of Baikunthpur block.

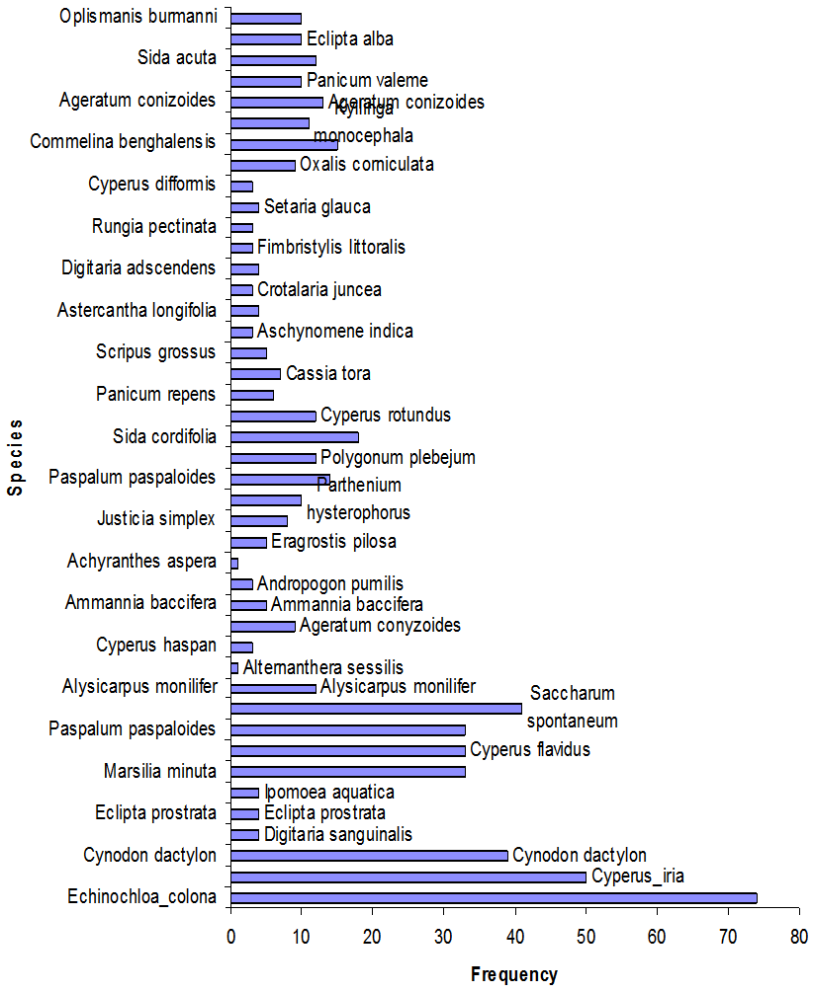

Figure 1. Frequency of weed flora of paddy field of Bailkunthpur Block.

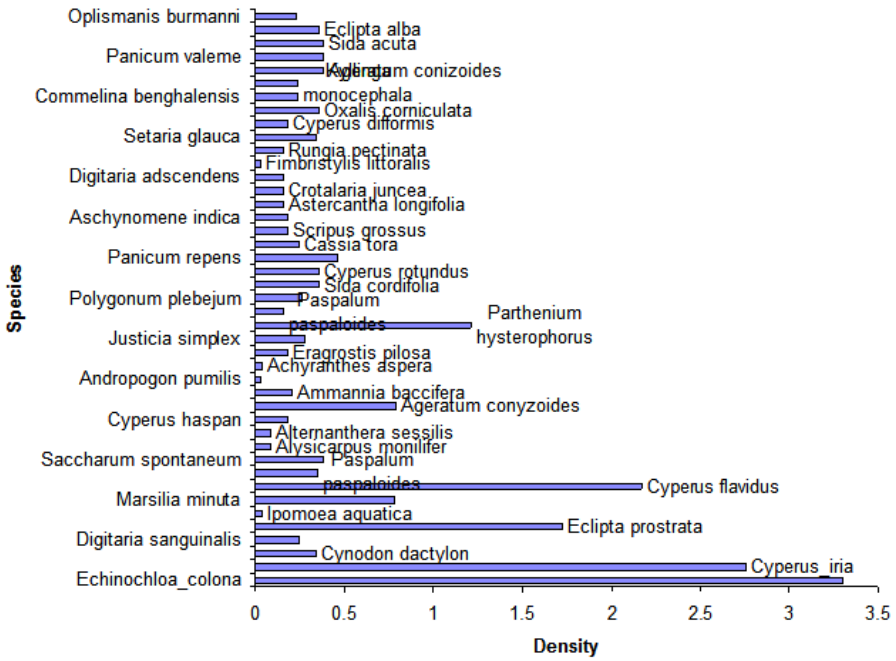

Figure 2. Density of weed flora of paddy field of Bailkunthpur Block.

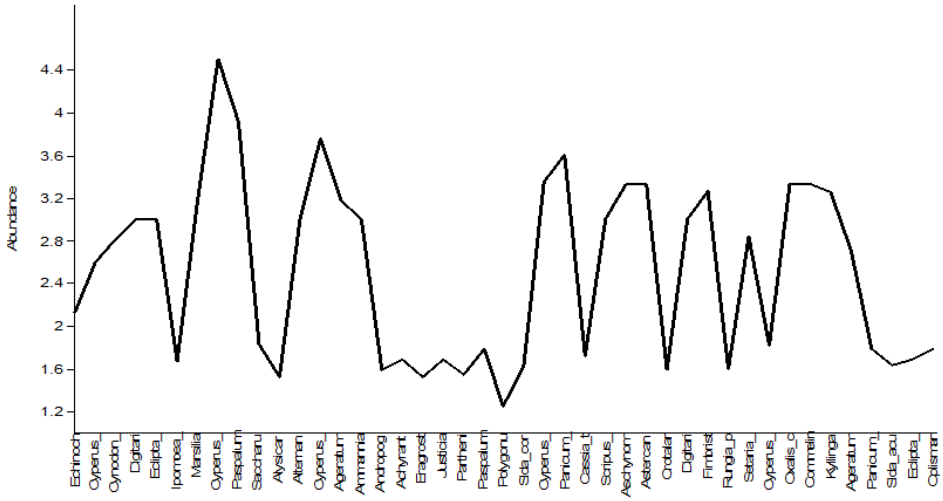

Figure 3. Variation in the Abundance of the studied Weed Flora.

Table 1. Importance Value Index (IVI) of Different Weeds Plant Species of Baikunthpur.

Plant species	Relative Density	Relative Frequency	Relative Dominance	I.V.I.
Echinochloa colona	1.07319	6.1527	38.1674	45.39329
Cyperus iria	1.175	8.29619	31.5562	41.02739
Cynodon dactylon	0.7319	0.9167	1.1041	2.7527
Digitaria sanguinalis	0.2927	0.7639	1.6961	2.7527
Eclipta prostrata	0.8783	0.3819	0.1293	1.3895
Ipomoea aquatica	0.1463	0.3055	0.7903	1.2421
Marsilia minuta	1.8296	1.5863	16.0289	19.4448
Cyperus flavidus	6.2927	1.5278	22.3611	30.1816
Paspalum paspaloides	1.4638	0.9167	13.3065	15.687
Saccharum spontaneum	0.763	0.113	10.446	11.322
Alysicarpus monilifer	0.8051	0.9617	12.6872	14.454
Alternanthera sessilis	1.017	0.291	10.0987	11.4067
Cyperus haspan	0.768	0.143	20.436	21.347
Ageratum conyzoides	1.017	3.069	21.208	25.294
Ammannia baccifera	0.763	1.228	18.5	20.491
Andropogon pumilis	0.2195	1.2987	13.6351	15.1533
Achyranthes aspera	0.04391	0.3055	20.0377	20.38711
Eragrostis pilosa	0.2927	1.06951	19.5748	20.93701
Justicia simplex	0.763	0.12	17.416	18.299
Parthenium hysterophorus	0.763	0.12	9.416	10.299
Paspalum paspaloides	1.272	0.744	11.415	13.431
Polygonum plebejum	1.017	0.4	12.175	13.592
Sida cordifolia	0.3659	0.4583	14.5029	15.3271
Cyperus rotundus	0.1463	0.9167	12.4511	13.5141
Panicum repens	0.8783	0.7639	13.1459	14.7881
Cassia tora	0.5123	0.9167	17.2561	18.6851
Scripus grossus	1.543	0.71	15.581	17.834
Aschynomene indica	1.272	0.597	10.689	12.558
Astercantha longifolia	2.544	2.725	12.249	17.518

Crotalaria juncea	1.017	0.415	16.983	18.415
Digitaria adscendens	0.391	0.6111	11.0978	12.0999
Fimbristylis littoralis	1.272	1.183	9.481	11.936
Rungia pectinata	0.3855	0.9167	12.9746	14.2768
Setaria glauca	0.8783	0.9931	11.0777	12.9491
Cyperus difformis	0.2195	0.6875	14.5807	15.4877
Oxalis corniculata	0.4391	1.1459	13.437	15.022
Alsicarpus monilifev	0.508	0.132	10.658	11.298
Commelina benghalensis	0.763	0.355	12.385	13.503
Kyllinga monocephala	0.508	0.57	14.0774	15.1554
Ageratum conizoides	1.017	0.136	17.576	18.729
Panicum valeme	0.763	0.612	14.124	15.499
Sida acuta	1.526	0.306	11.682	13.514
Eclipta alba	1.781	0.839	16.227	18.847
Oplismanis burmanni	0.508	0.207	20.0564	20.7714

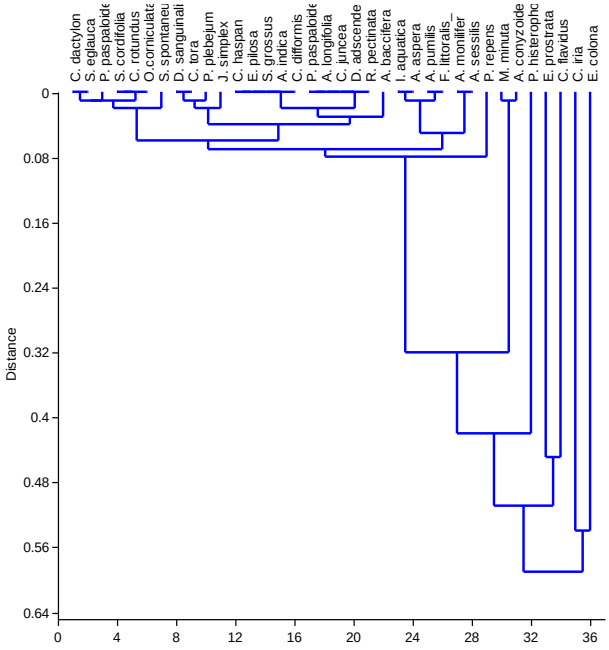

Figure 4. Dendrogram analysis of weed flora of Baikunthpur Block.

Table 2. Correlation analysis between phytosociological attributes of weed flora of different study sites of Baikunthpur.

	Density	Frequency	Ab	RD	RF	Rel Dom
Frequency	0.738*					
Abundance	0.161	0.086				
RD	0.390	0.276	0.437			
RF	0.748	0.639	0.112	0.171		
Rel Dom	0.556	0.482	-0.029	0.229	0.662	
IVI	0.648	0.552	0.048	0.340	0.757*	0.983

Relative dominance of weed species reflected higher values which therefore indicates their relative population strength among the diverse weed community.

The highest importance value index revels *E. colona*, *C. iria* and *C. flavidus* was most dominant among the observed weed community. The lowest IVI values represented by *C. dactylon*, *D. sanguinalis*,

E. prostrata, *I. aquatica* reflect that they are the rarest species in the weed community. Thus, *E. colona* is the dominant weed species of the concerned study site. The IVI value ranged between 1.2421 and 45.39329.

Cluster analysis of weed flora of Baikunthpur block on the basis of density reflected numerous clustering among different species indicating the closer density value, strong association between different weed species and homogenous distribution of species in their natural habitat (Figure 4).

Table 3. Diversity indices value of weed flora in Baikunthpur Block of Korea District.

Index	Value
Dominance_D	0.06997
Shannon_H	3.14000
Simpson_1-D	0.93000
Evenness_e^H/S	0.53720
Menhinick	9.34800
Margalef	13.76000
Equitability_J	0.83480
Berger-Parker	0.15600

Data presented in Table 2 reflects the results of correlation analysis among the phytosociological attributes of weed flora of Baikunthpur Block of korea district. From the correlation study it appears that density is significantly (P>0.05) and positively correlated with frequency and relative frequency. IVI value was found to be strongly correlated with frequency and relative dominance at 5% level of significance. Further frequency is positively correlated with relative frequency.

Diversity is the index of the ratio between the number of species and the important value of an individual. Shannon index value (3-14) was found to be considerably higher for the concerned study site. Thus, *Viola surpense* is the most dominant species of the study area.

The Evenness index value is very low for the Baikunthpur block which therefore indicates the species are clumped together within their habitat and therefore not evenly spaced.

DISCUSSION

The habitat is of immense value to mankind because the modern material civilization is entirely based on the exploitation and utilization of the existing resources drawn from the environment and created through human efforts. The controlling mechanisms of biodiversity in different ecosystems are mentioned by the theory of species richness which considers resource availability and disturbance as factors for structuring plant communities.

The concept of species diversity relates simply to “richness” of a community or geographical area in species. At the simplest level of examination, species diversity corresponds to the number of species present. Species diversity is considered to be an important attribute of community organization and allowed comparison of the structural characteristics of the communities. It is often related to community dynamics stability, productivity, integration, evolution, structure and competition. The idea of displacement of one species through competition with other is net prime importance.

Observations described above clearly indicate that *E. colona* and *C. iria* have been found to be most frequently distributed weed species in all the study sites sampled. Density-wise also, these two species were found the most populated species. Almost the same picture is seen with abundance also. This shows that data on density, frequency and abundance do not vary much with respect to cropping seasons and study sites.

The high number of weeds identified in this study could be attributed to the presence of a large weed seed bank in the soil that must have been deposited from previous years. Weeds have higher seed production that is easily dispersed through different ways with variable dormancy resulting in germination by flushes over a long period (Akobundu 1987). The persistent weed species give a severe competition to paddy crop and reduce the agricultural output.

The exhibition of a high level of persistence of the most important species of weeds as fore-runners in all their phytosociological attributes could not be unconnected to their similarity in their families morphology and development attributes. Most of the weed species with the highest density, frequency and abundance were of the grass family and sedges. These weeds have high fecundity producing hundreds of thousands of seeds during single growing season reproduce through vegetative propagules and seeds and have vegetative mimicry with crops in addition to long-time seed dormancy. (Akobundu 1987, Zimdahl 2007).

From the two years observations, it was found that weed growth occurs within forty one days after paddy sowing/planting and they may propagate by seeds and propagules or by both. The perennial weeds create the most serious problem in paddy fields. Major weeds produce a large number of seeds, which may remain in soil and serve as soil seed bank for the next cropping season. It can be emphasized that major weeds should be controlled at proper time to check reduction in paddy yield and they must be removed before flowering and fruiting to reduce the production of seeds that remain as soil seed bank for the following years.

For proper management of weed one should remember that most of the weeds flower and fruit during June to November. Weeding has to be done before this period to avoid the gradual development of weed bank in the soil under dormant condition which in further time period would germinate and propagate at faster rate to reduce the agricultural output.

CONCLUSION

The present study was conducted as a first ever attempt from the study area to explore and identify the weeds of paddy crop. This 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.

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