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Short Note

Studies on Weed Diversity and Phytosociology in Wheat Crop

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ABSTRACT

Rice-wheat is the dominant cropping system in Patna district where wheat is generally grown in winter season and a large area is sown by using seed drill machines. The present investigation is based on the study of biodiversity of weeds under zero tilled condition in Patna district of Bihar. The weed inventory surveys and phytosociological studies in wheat fields were conducted during 2016-19 to identify the weed flora composition, density, frequency and Importance value index of 30 major weed species in wheat. In the study, *Asteraceae* was found as the largest family in respect of weed species whereas *Poaceae* and *Leguminosae* family stood at the second position in terms of weed species. Phytosociological studies further revealed that *Phalaris minor* (6.48) and *Cynodon dactylon* (5.03) have larger relative frequency among other weed species while *Chenopodiumalbum*(5.18)and *Avena fatua*(4.44)have larger relative abundance in the study area. Studies on relative density of weeds revealed that densities of *Phalaris minor* (7.06) and *Chenopodium album* (5.65) were higher over other weed species and similar trends were also observed in respect of Importance value index of weeds. Therefore, while planning effective weed management strategy, these two weeds (*P. minor* and *C. album*) must be focused. The study will provide an appraisal of species through quantitative characters and will allow effective weed management decision.

KEYWORDS

Density, Importance Value Index, Phytosociology, Weedflora, Wheat GDP

Phytosociological studies of plant/weed provide knowledge of the dynamics and relative importance of a species in particular Phyto-societies or across Phyto-societies, assume enough relevance in crop-weed ecosystem. It gives an appraisal of species through quantitative characters which allow effective weed management decision.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 (Sinha, 2017). 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 of net prime importance.

The aim of phytosociological studies for weed science is similar to that of ecological studies. Weed science researchers should, however, take into account that the nature of agricultural experiments usually implies (1) plots with much smaller size than the one expected for phytosociological samplings; and (2) much stronger selection factors than those acting in the natural environment. Moreover, selection factors are usually momentaneous as the treatments are applied, e.g. distinct crop planting densities, row spacings or crop canopy structure; previous residual or frequent post-emergence herbicides applications, and sometimes the unknown use history of the area. In this context, the use of phytosociological methods for weed science should be directly associated with the nature of the treatments applied, considering as mandatory a common history for all the area where the whole experiment will be installed, with no differential selection factors other than those comprised by the treatments. In long-term field trials, phytosociological surveys may be more comprehensively interpreted because of the larger size of the plots and the consolidation of a "system" in each one of the treatments. In addition, the soil seed bank of plant species will tend to be equalized and to reflect more reliably the effects of management (Concenco *et al.*, 2013). In other words, plant communities in long-term, consolidated trials are usually more closely in conformity with Gleason's theory of gradient occurrence of species as the selection factors are changed. The methods used in plant sociology rely on two key points: (1) sampling the areas accurately and (2) describing the plant community as clearly as possible so that the data can reflect the real plant community.

Wheat (*Triticum aestivum*) is a significant *rabi* crop (Meena *et al.*, 2016) in Patna district of Bihar, both in terms of acreage as well as productivity. The wheat fields are infested with a large number of weeds and weed infestation is one of the major constraints in crop production which results in heavy crop yield losses. Weed surveys are useful for determining the occurrence and importance of weed species in crop production systems (Dangwal, 2013). Documenting the kinds of weed species and its relative distribution facilitates the establishment of priorities for

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research and extension services.Weeds compete with crop plants for essential growth factors like light, moisture, nutrients and space. Apart from increasing the production cost, weeds also intensify the disease and insect pest problem by serving as alternative hosts, and uncontrolled weed growth throughout the crop growth caused a yield reduction of 57.6 to 73.2% (Tesfay *et al*., 2014).The extent of damage depends upon the nature of weeds, their density, dominance, ecological success and their association with the crop and other biotic and edaphic factors. Since not all the weed species are important to determine the nature of weed communities, it will be desirable to know the quantitative characters like density, frequency and importance value of individual species. Present study has been taken up to collect the information on distribution of weeds of wheat fields from different areas of Patna district for the first time (Nagaraju *et al*., 2014).

It is, therefore, necessary for rigorous survey of weeds in wheat fields, their distribution, relative occurrence and great need of research aiming at prevention of loss of yield due to weeds in wheat along with their management by most economic and feasible method. These objectives can be achieved through a better understanding of different weeds infesting the wheat crop in a particular area.

The study is based on extensive and intensive field surveys during the peak period of weed growth in three successive cropping seasons from 2016-2019. Field surveys at 100 random wheat fields of Patna district (24°20'10'' N~27°31'15''N (latitude) and 83°19'50'' E ~88°17'40''N longitude) under alluvium soil, were well explored covering all the geographical areas of the district for weed survey and phytosociological studies. Frequent field surveys were conducted at each site for collection of weed species at different growth stages. The collected weed plants were pressed, dried, preserved and properly identified with the help of available literature and experts on weed at ICAR-Research Complex for Eastern Region, Patna. 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. Later, these identifications were checked again with 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 weed sample. Abundance, density, frequency and their relative values as well as importance value index (IVI) were calculated by applying the following principles of Rew and Cousens, 2001. The following formulae were used to compute different phytosociological attributes:

$$\text{Frequency (F)} = \frac{\text{Total no. of quadrates in which the species occurs}}{\text{Total number of quadrates used}} \times 100$$

$$\text{Density (D)} = \frac{\text{Total no. of individuals of a species in all the quadrates}}{\text{Total number of quadrates studied}} \times 100$$

$$\text{Abundance (A)} = \frac{\text{Total number of individuals of a species in all the quadrates}}{\text{Total number of quadrates in which the species occurred}} \times 100$$

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

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

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

Importance Value Index (IVI) = Relative frequency + Relative density + Relative abundance

Weed flora

Weed flora is an integral part of ecosystem; nevertheless, by definition weeds are unwanted plants and are considered as nutrient competitor with economic crops that's why they face considerable threats in an agro-ecosystem (Khare and Shrivastava, 2004, Kumar *et al*., 2018). Phytosociological study of weeds provides knowledge of dynamics and relative importance of a weed species in a particular area or Phyto-society assumes large relevance in crop-weed relationship. It gives an appraisal of species through quantitative characters for effective management of weed in a particular area. From the findings, it appears that the total number of individual weeds (TNI) vary with species. During survey and phytosociological studies, a large number of weed species (40 Nos.) were collected from the wheat fields which were categorized with their family, type and according to the life span. A total of nineteen families were recognized. Asteraceae family belongs to largest number of weed species while Poaceae and Leguminosae family stood second in terms of number of weed species within the family. The most of the weeds were categorized as broad leaf weeds followed by grassy weeds (Table 1).

Weed density and frequency

Density measures (D) the number of individuals/area whereas; frequency (F) is the proportion of sampling units that contains the species (Patil *et al*. 2010). Frequency is a useful index for monitoring and comparing plant community changes over time. Frequency reflects both a species' presence or absence and how much it is distributed within a community. Frequency is an easy and quick method which is considerably affected by the size and the shape of the sampling units. It is more dependent on quadrat size than other measures of abundance. Use of large quadrats results in more species having 100% frequency, whereas in small quadrats, many frequencies are zero (Roger *et al*. 2015).

Table 1: Species diversification in wheat fields at Patna district

Weed Species	Family	Type	Life cycle
Amaranthus virdis L.	Amaranthaceae	BLW	Annual
Cirsium arvense L.	Asteraceae	Grassy	Perennial
Asphodelus tenuifolius Cav.	Asphodeliaceae	BLW	Annual
Avena fatua L.	Poaceae	Grassy	Annual
Chenopodium murale L.	Chinopodaceae	BLW	Annual
Cicharium intybus L.	Asteraceae	BLW	Perennial
Cyanodon dactylon L.	Poaceae	Grassy	Perennial
Phalaris minor L.	Poaceae	Grassy	Annual
Anagallis arvensis L.	Primulaceae	Grassy	Annual
Oxalis corniculata L.	Oxalidaceae	Grassy	Annual
Rumex retroflexus L.	Polygonaceae	Grassy	Annual
Parthenium hysterophorus L.	Asteraceae	Grassy	Annual
Solanum nigrum L.	Solanaceae	Grassy	Annual/ Biennial
Xanthium strumarium L.	Asteraceae	Grassy	Annual
Cyperus rotundus L.	Cyperaceae	sedge	Perennial
Fumaria parviflora L.	Papaveraceae	BLW	Annual
Euphorbia hirta L.	Euphorbiaceae	BLW	Annual
Fumaria indica (Hausskn)	Papaveraceae	BLW	Annual
Lathyrus sativa L.	Leguminosae	BLW	Annual
Lepidium sativum L.	Brassicaceae	BLW	Annual
Malva parviflora L.	Malvaceae	BLW	Annual/ Perennial
Medicago polymorpha L.	Leguminosae	BLW	Annual
Meliolotus indica L.	Leguminosae	BLW	Annual/ Biennial
Medicago denticulata L.	Leguminosae	BLW	Annual/ Biennial
*Polygonum plebejum*R. Br.	Polygonaceae	BLW	Annual
Polypogon monspeliensis (L.) Desf.	Poaceae	Grassy	Annual
Vicia sativa L.	Leguminosae	BLW	Annual
Vicia hirsuta L.	Leguminosae	BLW	Annual
Spergula arvensis L.	Spergulaceae	BLW	Annual
Chenopodium album L.	Amaranthaceae	BLW	Annual/ Perennial
Chrozophora tinctoria L.	Euphorbiaceae	BLW	Annual
Rumex dentatus L.	Polygonaceae	BLW	Annual/ Biennial
Lathyrus aphaca L.	Leguminosae	BLW	Annual
Abelmoschus moschatus Medik.	Malvaceae	BLW	Perennial
Convolvulus arvensis L.	Convolvulaceae	BLW	Annual
Melilotus alba Medik.	Leguminosae	BLW	Annual/ Biennial
Barbarea vulgaris L.	Brassicaceae	BLW	Biennial
Trifolium fragiferum L.	Leguminosae	BLW	Perennial
Physalis mimima L.	Solanaceae	BLW	Annual
Saponaria Vaccaria L.	Caryophyllaceae	BLW	Annual

Note: BLW= Broad leaf weed

Data in Table 2 represents total occurrence of an individual (TOI), total number of individual weed (TNI), frequency of individual weed species (F), density of individual weed species (D) and abundance of individual weed species (A).

Table 2: Phytosociological parameters of weeds collected from wheat fields in Patna district

Weed species	TQ	TOI	TNI	F	D	A	RF	RD	RA
Melilotus albus Medik.	50	5	12	22	0.24	2.40	1.48	1.54	3.39
Trifolium fragiferum L.	50	12	26	24	0.52	2.17	3.55	3.34	3.06
Xanthium strumarium L.	50	6	11	12	0.22	1.83	1.78	1.41	2.59
Rumex retroflexus L.	50	10	22	20	0.44	2.20	2.96	2.83	3.11
Parthenium hysterophorus L.	50	13	38	26	0.76	2.92	3.85	4.88	4.13
Physalis mimima L.	50	12	28	24	0.56	2.33	3.55	3.60	3.30
Cynodon dactylon L.	50	18	38	36	0.76	2.24	5.03	4.88	3.15
Phalaris minor L.	50	22	55	42	1.1	2.52	6.48	7.06	3.53
Chenopodium album L.	50	12	42	32	0.88	3.67	3.55	5.65	5.18
Anagallis arvensis L.	50	11	28	32	0.56	2.55	3.25	3.60	3.60
Oxalis corniculata L.	50	8	25	16	0.5	3.13	2.37	3.21	4.42
Vicia sativa L	50	10	21	20	0.42	2.10	2.96	2.70	2.97
Medicago denticulata L.	50	5	14	10	0.28	2.80	1.48	1.80	3.96
Trifolium fragiferum L.	50	7	20	14	0.4	2.86	2.07	2.57	4.04
Spergulus arvensis L.	50	11	30	22	0.6	2.73	3.25	3.86	3.85
Amaranthus viridis L.	50	16	20	24	0.4	1.25	4.73	2.57	1.77
Avena fatua L.	50	13	32	26	0.64	2.46	3.85	4.11	3.48
Sonchus asper L.	50	7	22	14	0.44	3.14	2.07	2.83	4.44
Fumaria parviflora L.	50	12	35	24	0.7	2.92	3.55	4.50	4.12
Euphorbia hirta L.	50	15	25	28	0.5	1.67	4.44	3.21	2.36
Vicia hirsuta L.	50	6	14	12	0.28	2.33	1.78	1.80	3.30
Rumex dentatus L.	50	10	24	20	0.48	2.40	2.96	3.08	3.39
Polypogonmon speliensis L.	50	9	20	18	0.4	2.22	2.66	2.57	3.14
Cirsium arvense L.	50	16	26	22	0.52	1.63	4.73	3.34	2.30
Barbarea vulgaris L.	50	13	31	16	0.62	2.38	3.85	3.98	3.37
Lathyrus aphaca L.	50	14	34	30	0.68	2.43	4.14	4.37	3.43
Lathyrus sativa L.	50	9	22	18	0.44	2.44	2.66	2.83	3.45
Lepidium sativum L.	50	11	25	22	0.5	2.27	3.25	3.21	3.21
Convovulus arvensis L.	50	11	18	22	0.36	1.64	3.25	2.31	2.31
Melilotus indica L.	50	15	20	30	0.4	1.33	4.44	2.57	1.88

The most frequent species were *Phalaris minor* (42%), *Cynodon dactylon* (36%), *Anagallis arvensis* (32%), *Chenopodium album* (32%) and *Lathyrus aphaca* (30%), whereas total number of individual species was found highest with *Phalaris minor* (55) *Chenopodium album* (40), *Parthenium hysterophorus* (38), *Cynodon dactylon* (38), and *Lathyrus aphaca* (34/m2) (Singh *et al.*, 2019). Likewise, *Phalaris minor* (1.1), *Chenopodium album* (0.84), *Parthenium hysterophorus* (0.76), *Cynodon dactylon* (0.76) and *Lathyrus aphaca* (0.68) resulted in maximum weed density of individual weeds in the surveyed area. Most of the plant species reflecting lower density values indicates single plant dominated community structure of weed flora (Hajari *et al.*, 2019).

Here, density value of weeds ranges from 0.4 to 1.1 and*Phalaris minor, Chenopodium album, Cynodon dactylon,*

Parthenium hysterophorus and *Lathyrus aphaca* be considered as the dominant weed flora among the weed community prevailing over the wheat fields of Patna district.Observations described above indicated that *Phalaris minor* and *Chenopodium album* have been found to be the most frequently distributed weed species in the study area. Density wise also, these two species were found most populated species. Almost the same picture is seen with abundance too with a difference of *Avena fatua* species which has also shown higher degree of abundance.

Relative abundance, relative frequency and relative weed density

Relative abundance or degree of dominance of individuals among different species is another important indicator of biodiversity of weeds, which usually refers 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. There is higher abundance of *Oxalis corniculata* (2.13) and *Avena fatua* (3.14) in the wheat fields of selected area whereas, relative abundance value was found higher with the weed species *Chenopodium album* (4.94), *Avena fatua* (4.44), *Oxalis corniculata* (4.41), *Parthenium hysterophorus* (4.13) and *Trifolium fragiferum* (4.03). Most of the weed species with the highest density, frequency and abundance were of grass and broad leaf family. 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 (Jakelaitis *et al*., 2003).

Relative frequency, also expressed as a percentage and relative frequency distribution value represented in Table 2, reflects significant level of variation among different observed weed species. The value of Relative frequency was found to be the highest for *Phalaris minor* (6.21) which was followed by *Chenopodium album* (5.33). The relative frequency distribution of different weed species reflects lower values which can be interpreted as the relative proportion of occurrence of species to each other is very low (Ilias *et al.* 2018).

Relative density value was found to be the highest for *Phalaris minor* (7.06) which was followed by *Chenopodium album* (5.39). These two weed species clearly reflect their dominance among the other weed community in the wheat fields of Patna district (Table 2). The high number of weeds identified in the study area could be attributed to the presence of large weed seed bank in the soil that must have been deposited from previous years. The persistent of weed species gave a severe competition to wheat crop and reduce the economic biomass i.e. grain yield. The result was found in conformity with the findings of Pragada and Venkaiah (2012).

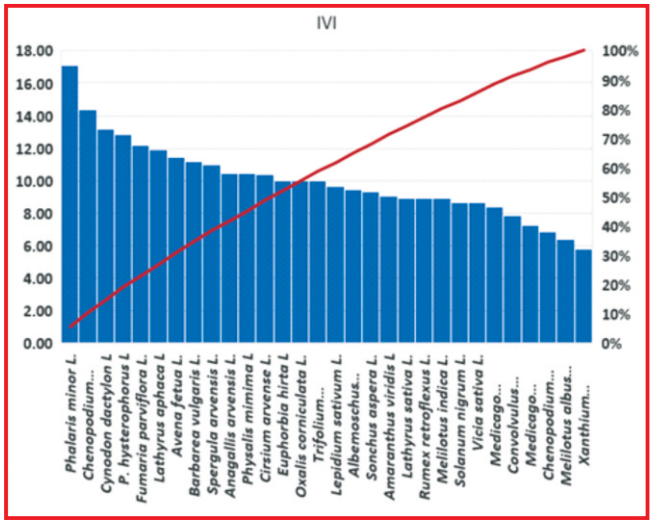

Fig.1: Importance Value Index of weed species in wheat fields

Importance value index (IVI)

The highest Importance value index (IVI) was observed with*Phalaris minor, Chenopodium album, Cynodon dactylon* L., *Parthenium hysterophorus* L. and also represented themselves as most dominant among the observed weed community. The lowest IVI.

values represented by *Xanthium strumarium, Melilotus albus, Chenopodium murale, Medicago denticulata* reflects that these weed species rarely grow in the area and need not to be focused for its control (Fig. 1). In Patna district *Phalaris minor* is the most dominant weed species and proper control measures should be taken to control this weed species. The weed species with high IVI and frequency might compete better to reduce growth and yield of associated crop (Vida *et al*., 2006).

The present study was conducted as an attempt to explore and identify the weeds of wheat crop in Patna district. From the above data now it can be emphasized that major weed should be controlled at proper time to check the reduction in wheat yield and they must be removed before flowering by any means either with the use of herbicides/mechanically or herbicides supplemented with cultural practices (hand weeding) to reduce the seed production.Weeding should be done before booting stage in wheat i.e. in the month of Feb-early March to avoid the gradual development of seed bank in the soil and also to minimize the competition among crop and weeds for water and nutrients. The information regarding taxonomy and phytosociological attributes of wheat fields of study area to government and non-government organizations will helpful in planning effective weed management strategies and policy for the crop. The present study will also be equally useful for the agriculturists and researchers of the study area in planning a suitable weed management strategy.

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