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Life form analysis of weeds from Paddy agro–ecosystem at Imphal East, Manipur, North – Eastern India

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ABSTRACT

Plants can be grouped in life-form classes based on their similarities in structure and function. A life-form is characterized by plant adaptation to certain ecological conditions and is an important part of vegetation description, ranking next to floristic composition. Altogether 62 species were found in the explorative survey from paddy agroecosystem and placed covering the main physiognomic structures as per Raunkier (1934) that included 34 monocot and 28 dicot species belonging to 15 families under 48 genera. The dominant families were Poaceae, Asteraceae, Cyperaceae and Amaranthaceae. In the floristic spectrum, the most represented life-forms were Chamaephytes followed by Hemicryptophytes. The percentage contribution of Poaceae was 43.55% followed by Cyperaceae and Asteraceae as 9.68% each. Chamaephytes (37.09%), Hemicryptophytes (29.04 %), Therophytes (14.52%), Cryptophytes (12.90 %) and Phenerophytes (6.45%) were the different life forms recorded. The biological spectrum was compared with Raunkiaer's 'normal spectrum' which acts as a null model against which different life-form spectra could be compared, pointing out that Chamae-Hemicrytophytic life-form characterized the phytoclimate of the agroecosystem under the present study.

Key word: *Agroecosystem, Weeds, Life Form, Biological Spectrum*

Introduction

Agroecosystems are domesticated ecosystems, intermediate between natural ecosystems (e.g. grassland and forests) and fabricated ecosystems (e.g. cities) and open systems whose products (food, fodder, fibre, fuel, etc.) are transported out of its boundary to human ecosystem (Odum, 1984). Indian agroecosystem occupies over 43.2 percent of the country's geographical area (142 Mha out of total area of 328.8 Mha) and is the most dominant terrestrial ecosystem in the country, whereas only 6.2 percent of total geographical area of Manipur is occupied by agroecosystem in the state (Dadhwal *et al.* 1995). Weeds affect adversely the yield resulting in the increase in the production costs and economic losses. Various management practices have been adopted to fight the threat of weeds in the agroecosystems. The functional classification of weeds in agroecosystems provides valuable inputs prioritizing management efforts for different weeds in the crops.

During the past few decades, rapid changes in agricultural practices have taken place in many countries. According to Bhat and Singh (2000) weeds spatially coincide with crop resulting in the yield reduction and depriving the crops from mineral nutrients, moisture, space and sunlight and disrupt many physiological processes. It is opined by Buhler *et al.* (2000) that the weeds in the agro-systems are required to be managed for sustainable crop production.

Weeds represent a highly specific and biologically important component of their environments. Their persistence is remarkable in view of the efforts to eliminate them, and warrants greater attention (Radosevich and Holt, 1984). Weeds reduce crop yields by competing with crop for water and nutrients, harbouring various insect pests, acting as hosts for different micro-organismal diseases and by blocking irrigation -drainage systems. In the world, several studies described the effects of one or few agronomic factors on weed biology and ecology like Mahn (1984), Mohlerand Liebman (1987), and Sheng *et al.* (1994). Knowledge of the interrelationships between the environmental conditions, agricultural practices and floristic composition of the weed communities would help in proposing future integrated weed control strategies. Knowledge of weed distribution, dynamics of weed populations, nature of weeds and factors affecting their distribution is required for developing site-specific, sustainable and eco-friendly integrated weed management programs.

Study Area, Materials and Methods

A study was conducted in paddy agro-ecosystem at Imphal East district, Manipur, North East India located at 24°462 21.76" N Latitude and 93°572 23.76" E Longitude at an elevation of 779 mmsl. The climate is subtropical; the climatic features are represented in the Ombrothermic Diagram (Fig. 1). The agro-ecosystem is rainfed with fertilizer-based cultivation of rice followed conventionally. In rabi season, cultivation of vegetables is preferred like potato, peas, tomato, cabbage etc. After harvesting, rice residue was annually removed in the studied site.

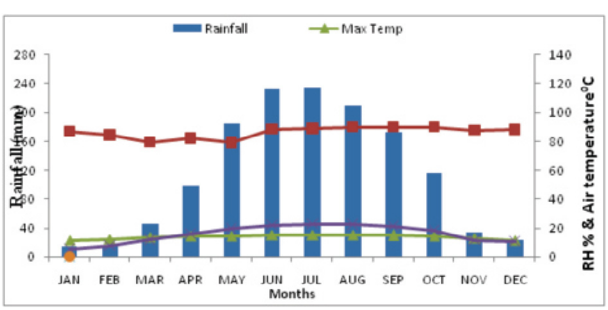

Fig. 1. Ombrothermic Diagram for the Site based on meteorological data (2005- 2015).

Floristic survey of weeds emerged in the agro-ecosystem at Imphal East was surveyed and species recorded during 2014-2016 where the paddy was cultivated in the field. The recorded plants species were placed into various life-forms as per Raunkiaer (1934). The percentage of species belonging to different life forms viz. Phanerophytes (Ph), Chamaephytes (Ch), Crytophytes (Cr), Hemicryptophytes (H) and Therophytes (Th) were calculated using the following formula;

$$\text{Percentage of life-form} = \frac{\text{Number of species of a given life form}}{\text{Total number of species in all life forms}} \times 100$$

Results and Discussion

The concept of Life-Form in the study of vegetation was proposed for the first time by Humboldt (1806) who suggested the grouping of vegetation type on the physiognomic basis. Grisebach (1838) and Drude (1890) have emphasized the dependence of lifeforms on climate and assessed the role of species in vegetation with special reference to duration of protection to the perennating organs and mode of propagation. This has been established by Raunkiaer, (1934), a Danish ecologist who emphasized that the growth of higher plants depends on the initiation of tissues at the apices (meristems) and classified plants according to their "lifeforms",in which these meristems were held and protected.

The life form system of categorising plants is based primarily on the methods, by which plants survive the unfavourable season. The proportions of the flora in the various categories (which Raunkiaer called the biological spectrum) vary from one climate to another. The life form system is an early and still held as an useful attempt to relate plant morphology and life history to climate. The biological spectrum not only represents the climatic conditions but is also the most potent environmental factor representing the ecosystem, as it was demonstrated by Pandeya (1954). The essence of Raunkiaer's biological spectrum is also examined by Fekete and Laeze (1971) with emphasis on how it becomes a tool in phytogeography and plant ecology. Weeds persist because of our inability to cope with maximum crop production and massive recycling potentiality of weeds (Sen *et al.*, 1980). Detailed analysis of weed communities provides necessary information for understanding the nature of weeds. In the present study the life form and biological spectrum of weeds has been analysed after a detailed floristic study i.e., habit, height and nature of the perennating buds together with the occurrence of each species and the life forms is compared with the Raunkiaer's Normal Biological Spectrum.

The lifeform reflects the bioclimate of the area (Meher Homji, 1964). Biological spectrum not only represents the climatic conditions but the most potent environmental factor representing the ecosystem (Pandeya and Sharma, 1950). The essence of Raunkiaer's biological spectrum is also examined by Fakete and Laeza (1971) with emphasis on how it becomes a tool in phytogeography and plant ecology. The ratio of life forms of different species in terms of number or percentage in any floristic community is called Biological spectrum or the spectrum of the lifeforms (Milone and Milone, 1971). According to Malik *et al*., (2006) biological spectrum determines the nature of bioclimate or phytoclimate of the habitats. Therefore, it is important to study the floristic composition and life forms of different plants to find out phytoclimate zones of the area.

Table 1 reveals the plant species recorded in the agroecosystem at Imphal East and the assigned Life Forms. Fig 2 represents the percentage contribution of various life forms in the biological spectrum of the studied site.

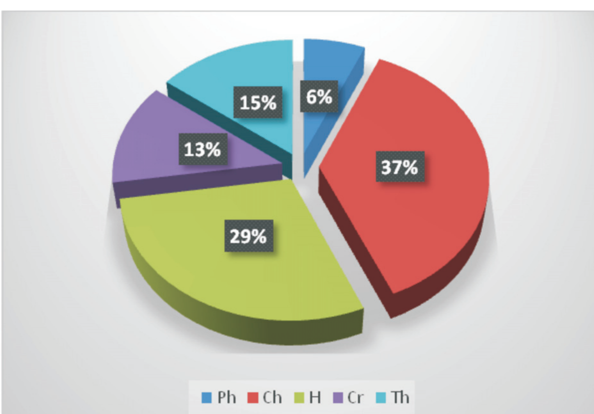

Fig. 2. Graphical representation of different life forms at the study site. Ph – Phanerophytes, Ch – Chamaephytes, H –Hemicrypophytes, Cr- Cryptophytes, Th –Therophytes.

The percentage of species belonging to different families relative to the total number of species is presented in Table 2 and Fig. 3 whereas Table 3 Fig 4 present the percentage representation of lifeforms in the agroecosystem and a comparison with

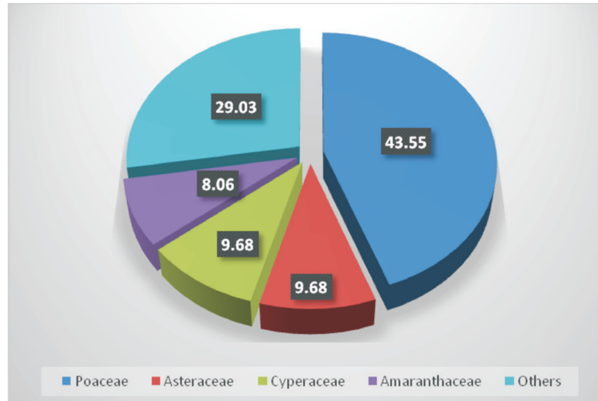

Fig. 3. Dominant families of weed species in paddy Agroecosystem at Imphal East, Manipur.

Raunkiaer's Normal biological spectrum(RNBS).

Life form pattern of the agroecosystem was found to be dominant by Chamaephytes (37.09%) followed by Hemicryptophytes(29.04 %). Therophytes represented 14.52 %, whereas Cryptophytes 12.90 % in the agroecosystem at Imphal East, Manipur. The life form Phanerophytes (6. 45 %) was the lowest contributor to the biological spectrum. Depending upon the percentage compositions of various life forms classes of the species in the study site, the phytoclimate of the agroecosystem was designated as Chamae-Hemicrytophytic as the maximum number of plants belonged to life-forms such as Chamaephytes and hemicrytophytes. Comparison is made with the Raunkiaer's normal spectrum of the life forms found in the present study (Fig. 3, Table 2) that revealed present findings reflected 4.12 times higher value than the percentage of Chamaephytes, 2.15 times in case of Cryptophytes/geophytes and 1.11 times in case of Hemicryptophytes and Therophytes

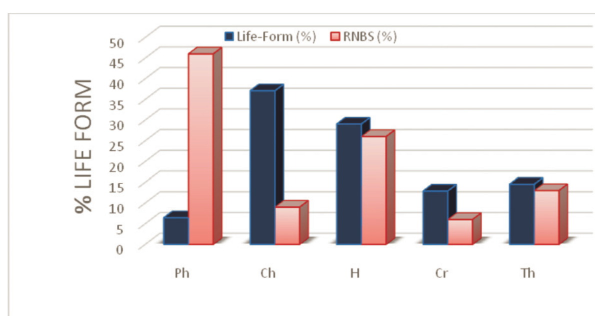

Fig. 4. Comparision of Biological Spectrum of weeds from paddy Agro-ecosystem at Imphal East, Manipur with Raunkiaer's Normal Biological Spectrum (RNBS)

Table 1. Life-form of weeds found in paddy Agroecosystem at Imphal East, Manipur
Ph-Phanerophytes, Ch – Chamaephytes, H –Hemicrypophytes, Cr - Cryptophytes, Th – Therophytes.

S.No	Name of the Species	Family	Life Form
1.	*Ageratum conyzoides* Linn.	Asteraceae	Th
2.	*Alternanthera philoxeroides* (Mart.) Griseb	Amaranthaceae	H
3.	*Alternanthera sessile* (Linn) R.Br. OXDC	Amaranthaceae	Th
4.	*Amaranthus spinosus* Linn.	Amaranthaceae	Ph
5.	*Amaranthus viridis* Linn.	Amaranthaceae	Ph
6.	*Arundinella nepalensis* Trin.	Poaceae	H
7.	*Arundo donax* Hook.	Poaceae	Ch
8.	*Auxonopus compressus* (Swartz.) P. Beauv.	Poaceae	Th
9.	*Avena sativa* Linn.	Poaceae	Cr
10.	*Centella asiatica* (L) Urban.	Apiaceae	H
11.	*Chenopodium album* Linn.	Chenopodiaceae	Ch
12.	*Chenopodium ambrosoides* Linn.	Chenopodiaceae	Ch
13.	*Chrysopogon aciculatus* (Ritz) Trim.	Poaceae	Cr
14.	*Commelina benghalensis* Linn.	Commelinaceae	Ch
15.	*Cymbopogon nardus* (Linn.) Rendle.	Poaceae	H
16.	*Cynodon dactylon* (Linn.) Pers.	Poaceae	Cr
17.	*Cyperus articulatus* Linn.	Cyperaceae	H
18.	*Cyperus brevifolius* (Rottb.) Hask.	Cyperaceae	H
19.	*Cyperus globosus* Allione.	Cyperaceae	H
20.	*Cyperus rotundus* L.	Cyperaceae	Cr
21.	*Dactyloctenium aegypticum* (Linn.) Willd	Poaceae	H
22.	*Desmodium heterophyllum* (Willd) DC.	Papilionaceae.	H
23.	*Dichanthium annulatum* (Forssk.) Stapf.	Poaceae	Cr
24.	*Digitaria sanguinalis* (Linn.) Scop.	Poaceae	Th
25.	*Drymaria diandra* Blum.	Caryophyllaceae	Ch
26.	*Echinochloa* sp.	Poaceae	Ch
27.	*Echinochloa stagina* (Retz).	Poaceae	H
28.	*Eclipta prostrata* Linn.	Asteraceae	Th
29.	*Eleusine indica* (L).	Poaceae	Ch
30.	*Eragrostis nutans* (Retz).	Poaceae	Ch
31.	*Eragrostis pilosa* Veauv.	Poaceae	Ch
32.	*Eclipta prostrata* (Roxb).	Poaceae	Ph
33.	*Fimbristylis ferruginea* (Linn.) Vahl.	Cyperaceae	Cr
34.	*Gnaphalium luteoalbum* Linn.	Asteraceae	Th
35.	*Gomphrena globosa* L.	Amaranthaceae	Ch
36.	*Gynura cusimbua* (D. Don) Moore.	Asteraceae	Th
37.	*Hydrocotyle javanica* Thumb.	Apiaceae	H
38.	*Imperata cylindrica* (Linn).	Poaceae	Cr
39.	*Ipomoea aquatica* Forsk.	Convolvulaceae	Ch
40.	*Justicia simplex*. D. Don.	Acanthaceae	Ch
41.	*Kyllinga brevifolia* Rottb.	Cyperaceae	H
42.	*Lindernia ciliata* (Colsm.) Pennell.	Scrophulariaceae	Ch
43.	*Mimosa pudica* Linn.	Mimosaceae	Ch
44.	*Narenga porphyrocoma* (Hance) Bor.	Poaceae	H
45.	*Oenanthe javanica* (Blume).	Apiaceae	Ch
46.	*Oxalis corniculata* Linn.	Oxalidaceae	H
47.	*Paspalum* sp.	Poaceae	Ch
48.	*Paspalum conjugatum* (P.J. Berguis)	Poaceae	Ch
49.	*Paspalumdistica* L.	Poaceae	Ch
50.	*Paspalum scrobiculatum* Linn.	Poaceae	H
51.	*Phragmites karka* (Retz.) Trin. ExSteud.	Poaceae	H
52.	*Polygonum barbatum* Linn.	Polygonaceae	H

Table 1. *Continued ...*
Ph-Phanerophytes, Ch – Chamaephytes, H –Hemicrypophytes, Cr - Cryptophytes, Th – Therophytes.

S.No	Name of the Species	Family	Life Form
53.	*Polygonum lapathifolium* Linn.	Polygonaceae	Ch
54.	*Polygonum orientale* Linn.	Polygonaceae	Ch
55.	*Sacciolepsis myosuroides* A. Camus	Poaceae	Ch
56.	*Sesbania sesban* (Linn.) Merr.	Papilionaceae	H
57.	*Setaria palludefusca* Schumach.	Poaceae	Ch
58.	*Sonchus oleraceus* Linn.	Asteraceae	Th
59.	*Spilanthes paniculata* Wall Ex DC.	Asteraceae	Th
60.	*Sporobolus indicus* (Linn) R. Br.	Poaceae	Cr
61.	*Stellaria media* Linn.	Caryophyllaceae	Ch

Table 2. Plant Families and species richness of Paddy Agroecosystem at Imphal East, Manipur.

S. No.	Plant Families	No. of Species	% Species
1	Acanthaceae	1	1.61
2	Amaranthaceae	5	8.06
3	Apiaceae	3	4.84
4	Asteraceae	6	9.68
5	Caryophyllaceae	2	3.23
6	Chenopodiaceae	2	3.23
7	Commelinaceae	1	1.61
8	Convolvulaceae	1	1.61
9	Cyperaceae	6	9.68
10	Mimosaceae	1	1.61
11	Oxalidaceae	1	1.61
12	Poaceae	27	43.55
13	Papilionaceae	2	3.23
14	Polygonaceae	3	4.84
15	Scrophulariaceae	1	1.61

Table 3. Comparison of life-form spectrum of the present study with Raunkiaer's Normal Biological Spectrum (RNBS).

Life-forms	No. of species	Life-form (%)	RNBS (%)
Phanerophytes	04	06.45	46.0
Chamaephytes	23	37.09	9.0
Therophytes	09	14.52	13.0
Cryptophytes	08	12.90	6.0
Hemicryptophytes	18	29.04	26.0

whereas the percentage of Phanerophytes was nearly 7.13 times less than the normal spectrum.

When compared with the Raunkiaer's Normal Biological Spectrum, our study on the weed flora of Paddy agroecosystem reflected a higher proportion than expected of the life-form classes with renewing buds close to the ground (Chamaephytes), also a higher proportion than expected for the life-forms with renewing buds under the ground (Hemicryptophytes and Cryptophytes), similarly better performance of species adapted to tide over the unfavourable period in the form of seed (Therophytes). According to Cain (1950) Therophyte developed especially in areas where native vegetation has been disturbed. According to Meher - Homji (1964), the life-form reflects the bioclimate of the area. The lowest representation in the biological spectrum was by the Phanerophytes with perennating buds above the ground in the unfavourable season.

Thus, performance of Chamaephytes affected other associated species through their competitive ability. Angom and Gupta (2006) also found similar results at the floating grasslands of Keibul Lamjao National Park, Manipur. Likewise the agroecosystem vegetation opened to various stresses like ploughing, soil disturbance, scraping, cutting and removal of harvest resulted in the better performance of Therophytes. The Therophytes are represented as third dominant life- form class in the study site indicating anthropogenic stress and disturbances operating in the system, also supported by workers like (Sharma, 2003; Sher and Khan, 2007; Khan *et al*., 2011). The study revealed that those plants which are best adapted to tide over the unfavorable period prevail in the agroecosystem of Imphal East. The rice fields represent a transitional ecosystem between the natural water and the field ecosystem; hence, the weed flora in rice cropland comprises species that naturally grow in water or marshy habitats and species belong to the group of common weeds of other summer crops in the area. The most extensive contributions on weed flora in the rice fields were those of Chakravarty (1957), Nagai (1959); Paul and Bhattacharyya (1959); Datta and Maiti (1963), and

Mahapatra *et al.* (1965).

Streibig (1979) reported that therophytes, hemicryptophytes, geophytes, and chamaeophytes constituted, respectively, 63%, 26%, 8%, and 3% of the weed flora in the crop fields of Denmark. According to Streibig (1979), the number of therophytes tended to decrease and the number of hemicryptophytes tended to increase with the increasing crop growth period. Hidalgo *et al*. (1990) reported 79%, 4%, and 8% of therophytes, hemicryptophytes, and geophytes/cryptophytes respectively, in the spring-sown dryland crops of the Córdoba region in Spain. Holt and Orcutt (1996) remarked that although producing a modest amount of seed for future generations, the geophytic weeds begin each growing season with underground carbohydrate reserves stored in the perennating parts, such as stolons, bulbs, tubers, and rhizomes that afford a tremendous competitive advantage over associated crops.

Of the 31 weed species, belonging to 11 families collected from rice fields in Fatehgarh District of Punjab between June and November 2017.,15 species were dicots and 16 were monocots of which 29 were annuals and only two, *Cyperus rotundus* and *Parthenium hysterophorus*, were perennials (Singh and Singh, 2019).

The phytoclimate was earlier reported from Manipur by workers like Usharani (2004) Angom and Gupta (2005); Ranita *et al*., (2010); Sanjoy *et al*., (2010); Beeteswari *et al.* (2009) Gupta and Singh (2013); Binita *et al*., (2014); Singh and Gupta, (2015); Usharani *et al.,* (2015), Arila and Gupta (2016); Singh and Gupta, (2016); Niirou and Gupta (2020). As the lifeform and biological spectrum of a region reflect upon the climate of that region, most of these spectrums for different regions are related to their bioclimate. However, the present study comprises the first of its kind in the Paddy Agro-system of Manipur, NE India. The present study will help the agriculturists and farm managers of the study area in planning a suitable strategy for weeds control.

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