Indian Journal of Weed Science **48**(4): 435–439, 2016
DOI: 10.5958/0974-8164.2016.00111.8

Short communication

Occurrence of fringe-rush in *Kharif* rice in Assam

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Received: 7 September 2016; Revised: 27 October 2016

Key words: *Kharif* season, *Fimbristylis*, Transplanted rice, Weed

Out of about 14 different rice cultures practiced in the plains of river Brahmaputra and Barak in Assam, transplanted *Kharif* rice is most commonly practiced. Presently 23.2 lakh hectares (Islam 2012) land is under rice cultivation in the state Assam and weed cause up to 60% yield loss (Anon. 1995 to 2015). Sedges are considered as the integral part of the vegetation of rice ecosystems in the entire Eastern and North-Eastern India to China and South East Asia (Londo *et al*. 2006, Rao *et al.* 2007). The members of *Cyperaceae* are the common occurrence in moist upland to medium low land situations; among them *Fimbristylis* spp. fringe-rush were reported as most problematic weeds of different irrigated and non-irrigated crops in India (Anon. 1995 to 2015, Murty and Venkaiah 2011). Apart from India, *F. miliacea* is among the three most dominant weeds in the rice fields of Bangladesh, Ceylon, Guyana, Indonesia, Malaysia, Surinam and Taiwan (Rao *et al.* 2007).

Depending upon the management practices and the predominant weed flora, the yield loss caused by weeds varied from one place to another. In India, 30-90% loss occurred in rice production due to weed infestation in the critical period of the crop growth. Ramzan (2003) reported 48% yield reduction due to weed in transplanted rice. Juraimi *et al.* (2013) reported *Fimbristylis miliacea* as a notorious weed of rice ecosystems causing 9-43% reduction of rice yield offering high magnitude competition for nutrients and space, in addition to its allelopathic effect on rice (Siddique *et al.* 2013). Based on such a background, the present study was undertaken to explore the dominant weed flora in transplanted *Kharif* rice in Jorhat district of Assam and to determine the status of *Fimbristylis* amongst the weeds.

The study area was situated in the Upper Brahmaputra Valley Zone of Assam (20°10A N – 27°20A N, to 93°37A E – 93°57A E) and comprised of 2851.00 sq. km area, where rice is the only major crop. The area experienced sub-tropical climate with average temperature ranged from 8 to 36 °C and around 2100 mm average rainfall. The relative humidity varied from 78 to 98%.

The present study was carried out in all the eight developmental blocks (DB) of Jorhat district, Assam during 2014-15. Farmers and agricultural officers of different regions were interviewed and based on their opinion study sites were selected; finally, 32 rice fields were surveyed (4 fields from each DB) in entire Jorhat district. During the survey, the age of the rice seedling was 45-60 days after transplanting and the water level was 5-10 cm above ground. Both quadrat and line transect methods (Akwee *et al.* 2010) were used to collect data from study area. Quadrats of 1 × 1 m size were plotted in random systematic design for collection of data from the study area by following the method as described by Kent and Coker (1994). Line transacts were laid towards the centre of each crop field. 8 to 12 numbers of quadrats (Fig. 1) were plotted in each field (altogether 290 quadrat were placed in the entire Jorhat district). All the plant species, enumerated in each quadrat, identified and counted. Herbarium specimens were prepared by following standard method given by Jain and Rao (1977). The mounted specimens were identified consulting different regional floras and standard Herbaria ('Assam' and 'Cal').

Ecological analysis of weed flora was done following quantitative measures as density,

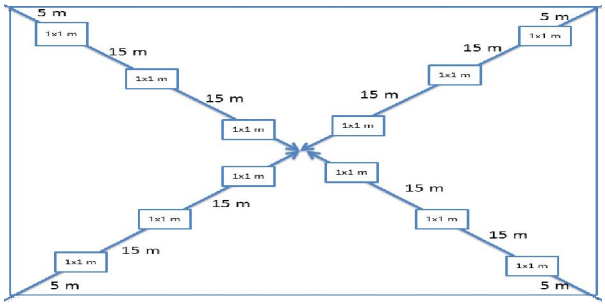

Fig. 1. Diagrammatic layout of quadrat for data collection

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frequency, and dominance and their absolute and relative values the importance value index (IVI) was calculated from the relative values. Summed dominance ratio (SDR) was calculated to simplify the dominance spectrum (IVI) of the weed species (Raju 1987).

A total of 58 different weed species, belonging to18 sedges, 11 grasses and 29 broad-leaved weed (BLW) species, were recorded in transplanted *Kharif* rice in Jorhat district during the study (Table 1). The five dominating families in the studied area were Cyperaceae, Poaceae, Onagraceae, Asteraceae and Fabaceae.

Status of sedges amongst the weeds

The study revealed that sedges were the dominant group of weeds in six out of the eight developmental blocks. The East Jorhat DB had the highest species diversity (13 species) (Fig. 2) and dominance (76.2%), which was 82.8% more than next largest group (BLW) (Fig. 3). This DB shared almost half of its border with the Nagaland Hills and nearly 50% of its land area is covered by forest and tea gardens, unlike the other developmental blocks. That might be one of the factors responsible for the dominance of sedges in the rice fields. Next highest sedge diversity (11 species) was recorded in Jorhat and Titabar developmental blocks, which are adjacent to East Jorhat DB and possessed considerable uplands covered with homestead woodlands and tea gardens. Sedge dominance in Jorhat DB was 51.73% higher than the BLW in the rice fields.

In the Central Jorhat DB, where the rice fields experience regular flooding from streams and tributaries, the species diversity and dominance of sedges were slightly lesser than the BLW. Species diversity of sedges in Majuli was considerably lower; it was 8 and 5 in Ujoni Majuli DB and Majuli DB, respectively. The dominance of sedges was almost equal to BLW in the Majuli DB, where the rice fields were affected by flood from river Brahmaputra and Lohit. On the other hand, in Ujoni Majuli DB, where the river originated flood was least in rice fields, the grasses were more dominant than the sedges and BLW weeds.

Status of *Fimbristylis* among the sedges

All together, 11 species belonging to *Cyperaceae* and one species belonging to *Xyridaceae* represented the sedge populations in the study area. Amongst sedges, *Fimbristylis* was the largest genus, with 5 species: *F. miliacea* (L.) Vahl, *F. littoralis* Gaudich., *F. bisumbellata* (Forssk.) Bubani, *F. tristachya* R. Br. and *F. ovata* (Burm. f.) J. Kern. The key for identification of these species indicated that the closely identical *F. miliacea* and *F. littoralis* can be identified in the field condition by carefully observing the stem. The stem is triangular in *F. littoralis* and triquetrous in *F. miliacea*. The five *Fimbristylis* species can be distinguished in the field condition by following the key:

Taxonomic "Key" for identification of *Fimbristylis* species:

1 a. Stem and leaves are extremely narrow and thread like, (plant height less than 12 cm.) ..……***F. ovata***

1 b. Stem and leaves are wider, never thread like, (plant height more than 12 cm.) ……..... (2)

2 a. Anthela often reduced to 1-2 spikelets, rarely more; bract setaceous, as long as or shorter than spikelet … ……..……..…….. ***F. tristachya***

2 b. Anthela with many spikelets; bracts usually foliaceous ……...…….... (3)

3a. Spikelet 2-5 mm long, in supra-decompound (less often decompounds) anthella; stigma 3; nuts trigonal ..... (4)

3b. Spikelets longer than 6 mm, in compound or decompounds (less often supra-decompound) anthella; stigma 2; nuts lenticular .....…***F. bisumbellata***

4 a. Stem triangular, Spikelet subglobose, obtuse; leaves equitant laterally flattened .. ***F. littoralis***

4 b. Stem triquetrous, Spikelet ovoid-oblong, acutish; leaves not equitant dorsoventrally flattened……***F. miliacea***

Out of five species of *Fimbristylis*, *F. miliacea* was recorded amongst the four dominant weeds in North West Jorhat, East Jorhat and Jorhat developmental blocks (Table 2). In the rice fields of Kaliapani DB and Ujoni Majuli DB *F. littoralis* was one of the four most dominant species. Prevalence of *Fimbristylis* in Majuli DB and Titabar DB was much lower compared to other developmental blocks.

In this study, *F. miliacea* was found to have the highest density in entire Jorhat District while *F. ovata* has the lowest (Fig. 3). Out of five *Fimbristylis* species, *F. miliacea* and *F. littoralis* jointly dominated the weed vegetation of transplanted *Kharif* rice in the entire district during critical period of crop weed competition. On the contrary, the moderately deep rooted problematic weed *F. bisumbellata* showed its presence in East Jorhat, Ujoni Majuli, Kaliapani, Titabar and Central Jorhat developmental blocks. The

Table 1. Estimated dominance indicating parameters of weed species in the study area

Species	Relative Density	Relative Frequency	Relative dominance	IVI	SDR
Cyperus brevifolius (Rottb.) Hassk.	0.15	0.46	0.27	0.88	0.29
Cyperus compressus L.	0.07	0.14	0.72	0.92	0.31
Cyperus difformis L.	0.32	1.30	3.50	5.12	1.71
Cyperus digitatus Roxb.	0.07	1.30	0.76	2.13	0.71
Cyperus haspan L.	1.11	3.29	0.48	4.88	1.63
Cyperus iria L.	4.45	2.78	17.36	24.58	8.19
Cyperus tenuispica Steud.	0.79	3.06	0.34	4.18	1.39
Xyris capensis Thunb.	0.09	0.46	0.04	0.59	0.20
Eleocharis acicularis (L.) Roem. & Schult.	25.35	4.68	2.75	32.78	10.93
Eleocharis acutangula (Roxb.) Schult.	2.91	2.18	5.05	10.13	3.38
Eleocharis dulcis (Burm.f.) Trin. ex Hensch.	1.72	1.85	2.99	6.57	2.19
Eleocharis geniculata (L.) Roem. & Schult.	4.19	2.13	1.82	8.13	2.71
Fimbristylis bisumbellata (Forssk.) Bubani	0.34	1.48	0.59	2.42	0.81
Fimbristylis littoralis Gaudich.	6.31	3.98	2.74	13.02	4.34
Fimbristylis miliacea (L.) Vahl	9.10	9.81	3.95	22.86	7.62
Fimbristylis ovata (Burm.f.) J.Kern	0.12	0.19	0.01	0.32	0.11
Fimbristylis tristachya R.Br.	0.85	1.34	1.47	3.66	1.22
Scirpus juncoides Roxb.	4.60	4.44	7.98	17.02	5.67
Cynodon dactylon (L.) Pers.	1.45	1.62	0.63	3.70	1.23
Cyrtococcum patens (L.) A.Camus	0.04	0.09	0.02	0.15	0.05
Dichanthium annulatum (Forssk.) Stapf	1.75	2.27	0.76	4.78	1.59
Digitaria setigera Roth	1.10	1.30	0.48	2.87	0.96
Echinochloa colona (L.) Link	0.01	0.14	0.02	0.17	0.06
Eragrostis unioloides (Retz.) Nees ex Steud.	2.18	1.53	0.95	4.65	1.55
Isachne himalaica Hook.f.	12.62	6.39	5.47	24.49	8.16
Oryza rufipogon Griff.	0.13	0.51	0.23	0.87	0.29
Paspalum conjugatum P.J.Bergius	0.65	0.65	1.12	2.42	0.81
Paspalum distichum L.	0.08	0.46	0.13	0.67	0.22
Sacciolepis myosuroides (R.Br.) A.Camus	1.16	2.45	2.02	5.64	1.88
Ammannia peploides Spreng.	0.01	0.23	0.00	0.24	0.08
Anthocephalus cadamba (Roxb.) Miq.	0.03	0.51	0.13	0.67	0.22
Alternanthera sessilis (L.) R.Br. ex DC.	1.18	1.94	4.61	7.74	2.58
Ageratum houstonianum Mill.	0.31	1.25	2.18	3.74	1.25
Corchorus capsularis L.	0.01	0.19	0.04	0.23	0.08
Commelina diffusa Burm.f.	0.00	0.09	0.01	0.10	0.03
Drymaria cordata (L.) Willd. ex Schult.	0.01	0.09	0.03	0.13	0.04
Desmodium triflorum (L.) DC.	0.14	0.79	0.06	0.99	0.33
Eriocaulon abyssinicum Hochst.	1.84	0.93	0.80	3.56	1.19
Eclipta prostrata (L.) L.	0.00	0.05	0.02	0.07	0.02
Hydrolea zeylanica (L.) Vahl	0.02	0.46	0.03	0.51	0.17
Ludwigia perennis L.	0.03	0.28	0.21	0.52	0.17
Ludwigia linifolia Poir.	0.75	5.79	5.21	11.74	3.91
Limnophila heterophylla (Roxb.) Benth.	0.01	0.28	0.00	0.29	0.10
Limnophila heterophylla (Roxb.) Benth.	0.03	0.09	0.01	0.14	0.05
Ludwigia adscendens (L.) H.Hara	0.29	0.42	2.03	2.74	0.91
Lindernia anagallis (Burm.f.) Pennell	0.59	1.71	1.03	3.34	1.11
Marcelia minuta L.	1.22	2.73	0.53	4.49	1.50
Murdannia nudiflora (L.) Brenan	0.53	1.62	0.93	3.08	1.03
Monochoria vaginalis (Burm.f.) C.Presl	0.07	1.06	2.07	3.20	1.07
Melochia corchorifolia L.	0.00	0.14	0.01	0.15	0.05
Oldenlandia diffusa (Willd.) Roxb.	0.70	3.19	0.31	4.20	1.40
Oxalis debilis Kunth	0.21	1.16	0.37	1.74	0.58
Phyllanthus niruri L.	0.04	0.74	0.25	1.03	0.34
Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne	4.64	6.71	8.05	19.41	6.47
Rotala indica (Willd.) Koehne	3.51	4.72	6.09	14.32	4.77
Scoparia dulcis L.	0.01	0.14	0.01	0.16	0.05
Sonchus oleraceus (L.) L.	0.00	0.14	0.00	0.14	0.05
Unknown species	0.10	0.28	0.38	0.76	0.25

Table 2. Estimated dominance indicating parameters of weed species in transplanted *Kharif* rice of eight developmental blocks of Jorhat district (Assam) during 2015

Weed groups and most dominant species	Relative Density	Relative Frequency	IVI	SDR
N.W. Jorhat DB				
1 *Cyperus iria* L.	25.96	6.97	89.54	29.85
2 *Fimbristylis miliacea* (L.) Vahl	20.89	11.85	37.80	12.60
3 *Ludwigia linifolia* Poir.	1.39	9.06	15.83	5.28
4 *Isachne himalaica* Hook.f.	9.93	8.36	20.70	6.90
Central Jorhat DB				
1 *Eleocharis acicularis* (L.) Roem. & Schult.	52.96	9.94	71.92	23.97
2 *Rotala rotundifolia* (Buch.-Ham. Ex Roxb.) Koehne	6.54	6.41	30.80	10.27
3 *Rotala indica* (Willd.) Koehne	7.42	6.41	34.06	11.35
4 *Eriocaulon abyssinicum* Hochst.	8.45	6.41	20.62	6.87
East Jorhat DB				
1 *Eleocharis acicularis* (L.) Roem. & Schult.	43.93	7.85	58.23	19.41
2 *Eleocharis acutangula* (Roxb.) Schult.	11.50	16.23	54.72	18.24
3 *Fimbristylis miliacea* (L.) Vahl	8.94	13.61	27.79	9.26
4 *Scirpus juncoides* Roxb.	15.06	13.61	64.01	21.34
Jorhat DB				
1 *Fimbristylis miliacea* (L.) Vahl	18.45	10.06	33.04	11.01
2 *Eleocharis acicularis* (L.) Roem. & Schult.	9.01	3.25	12.82	4.27
3 *Cyperus iria* L.	23.34	6.21	81.04	27.01
4 *Isachne himalaica* Hook.f.	9.01	7.40	18.62	6.21
Kaliapani DB				
1 *Rotala rotundifolia* (Buch.-Ham. ex Roxb.) Koehne	8.83	6.80	34.66	11.55
2 *Rotala indica* (Willd.) Koehne	6.80	8.06	29.53	9.84
3 *Fimbristylis littoralis* Gaudich.	17.40	7.30	34.09	11.36
4 *Eleocharis acicularis* (L.) Roem. & Schult.	19.63	7.56	29.83	9.94
Majuli (Lower) DB				
1 *Cyperus difformis* L.	6.31	8.42	44.69	14.90
2 *Scirpus juncoides* Roxb.	14.24	11.39	36.45	12.15
3 *Alternanthera sessilis* (L.) R.Br. ex DC.	20.36	7.43	62.61	20.87
4 *Cynodon dactylon* (L.) Pers.	20.05	9.90	33.76	11.25
Titabar DB				
1 *Eleocharis geniculata* (L.) Roem. & Schult.	24.62	8.10	46.25	15.42
2 *Eragrostis unioloides* (Retz.) Nees ex Steud.	15.49	8.45	32.45	10.82
3 *Isachne himalaica* Hook.f.	31.43	4.93	53.64	17.88
4 *Ludwigia adscendens* (L.) H.Hara	2.13	3.17	24.08	8.03
Ujoni Majuli DB				
1 *Fimbristylis littoralis* Gaudich.	23.82	2.68	38.29	12.76
2 *Paspalum conjugatum* P.J.Bergius	9.60	6.71	35.33	11.78
3 *Isachne himalaica* Hook.f.	35.55	10.07	63.21	21.07
4 *Rotala rotundifolia* (Buch.-Ham. ex Roxb.) Koehne	3.81	10.07	21.42	7.14

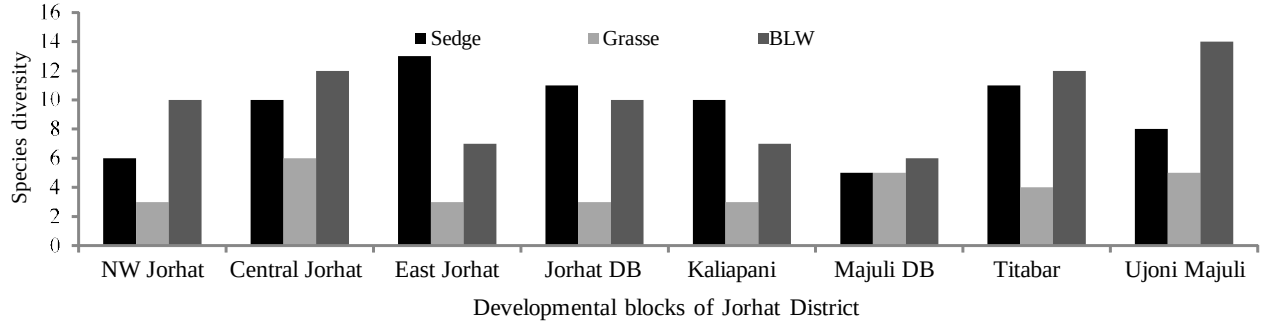

Fig. 2. Sedges, grasses and broad-leaved weed (BLW) weeds species diversity in transplanted *Kharif* rice in eight developmental blocks of Jorhat district, Assam

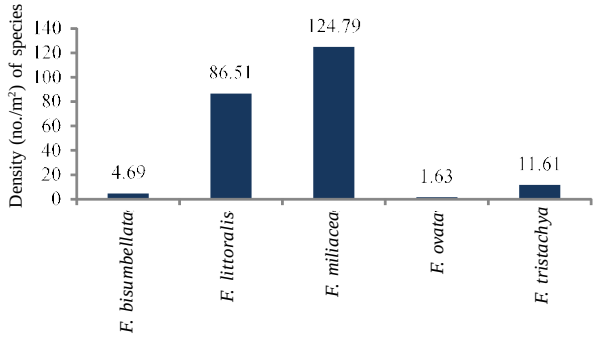

Fig. 3. Density (no./m²) of *Fimbristylis* species in Jorhat District

other two *Fimbristylis* species namely *F. ovata* and *F. tristachya* had occasional appearance in the rice fields.

SUMMARY

Among the sedges *Fimbristylis* are considered as very problematic weed in both irrigated and non irrigated rice ecosystems as it was reported to reduce rice yield by 9-43%. This work was undertaken, in 2014 and 2015, to assess the status of *Fimbristylis* species in transplanted *Kharif* rice at Jorhat district, Assam. Weed flora was surveyed following standard weed survey protocol. A taxonomic key for identification of these 5 taxa was developed for their easy reorganization in field condition. The moderately deep rooted problematic weed *F. bisumbellata* recorded in East Jorhat, Ujoni Majuli, Kaliapani, Titabar and Central Jorhat developmental blocks, as one of the most problematic weeds of upland autumn rice and other field crops of marshy situation during summer season. High frequency and population density of *Fimbristylis* species may be attributed to suitability of agro-climatic condition of Jorhat district for their growth and development and their occurrence has always caused yield reduction in rice due to higher magnitude of competition for nutrient and space in addition to its allelopathic effect on rice.

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