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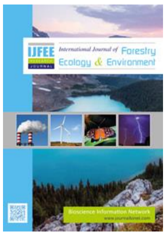

Weeds diversity in T. *aman* rice field under high Ganges river floodplain, Bangladesh

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ABSTRACT

To identify the predominant weed flora composition and severity of the prevailing weed flora, surveys were conducted in Jashore from July to December 2021 in T. aman rice fields. Ten fields were randomly selected from each of the three upazila such as Jhikargacha, Monirampur and Keshabpur. The quantitative surveying technique employing a 0.25 m² quadrate and 16 samples (excluding canals, pits, and field edge) per each field was considered for the survey following zig-zag pattern. Sampling was done, while the age of rice plants were 65 days. The weed species were identified and the frequency, field uniformity, density and relative abundance value were estimated for each species. A total of 46 weeds belonging to 20 families were identified, comprising 25 annuals and 21 perennials; 11 grasses, seven sedges, 27 broadleaves and one fern. The result showed that Poaceae was the top most dominant family contributing 11 weeds, while Cyperaceae ranked second with seven weeds. Based on relative abundance (RA) value, the top 10 most abundant weed species in descending order were Echinochloa crus-galli (34.41), Fimbristylis miliacea (22.14), Echinochloa colonum (16.56), Monochoria vaginalis (16.04), Eleocharisatro purpurea (12.96), Lindernia hysopioides (12.59), Ludwigia hyssopifolia (12.09), Digitaria sanguinalis (11.05), Lindernia antipoda (10.44) and Cyperus difformis (9.88). According to RA value, annual weeds (RA value: 138) were more dominant over perennials (RA value: 162). Moreover, broadleaves had a higher abundance value (150.3) than grasses (93.6) and sedges (56.1). Hence, the management strategies should be designed based on the latest results rather than any countrywide blanket recommendation.

Key Words: *Field uniformity, Frequency, Relative abundance, Survey, Weed control efficiency and Weed diversity.*

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I. Introduction

Globally, 20% of all daily calories come from rice (*Oryza sativa*), the substantial mainstay diet for over 50 percent of the global community (Dass et al., 2016). Greater than 50 percent of the global rice

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production is supplied from Asia (Awan et al., 2015). In Bangladesh, rice is cultivated in the *aus*, *aman*, and *boro* seasons under three different situations: rainfed, deep water, and irrigated. T. *aman* rice encompasses the largest amount of cropland among the three different seasons, which covers 5.63 million hectares (48.06% of total cropland) and provides about 14.44 million metric tons of rice (38.39% of total rice production) (BBS, 2021).

Numerous biotic and abiotic components and different socioeconomic and agricultural production-related challenges affect plant output (Ghersa et al., 2013). Innovative approaches must be devised to sustain agriculture productivity to minimize the bad impacts of those stressors. Biogenic factors can significantly reduce crop output with abiotic stresses, particularly the absence or surplus of water throughout the growing period, excessive temperature levels, excessive or insufficient sunshine, and mineral availability (Oreke, 2006). Amongst the principal biological barriers, weed serves as the most significant biogenic hindrance to crop productivity affecting both growing and advanced nations. Weed has a few distinguishing features, like quick seed dormancy, greater seed germination rates, environmental plasticity, rapid seedling development and breeding potential, narrow life spans, self-compatibility, efficient and well-structured techniques of grain dispersion, production of various forms of phytochemicals, and tolerance to abiotic and biogenic stressors (Baker, 1974; El-Sheikh, 2013). This permits the weed vegetation to thrive and flourish under diversified ecosystems, which encourages them to evolve as the most dominant across the entire earth (Holm et al. 1977) as well as to affect the regional biodiversity (Duke, 1983; Tilman, 2000). Weed causes massive damage to crop plants by raising the expenses of various farming techniques, lowering the efficiency of farming machinery as well as the quality of productive farmlands, and inhibiting crop seed germination because of phytochemicals (Algandaby and Salama, 2018). Competition from weeds typically reduces rice output by 40–60%, but this may surpass 94-96% due to improper weed management (Chauhan and Johnson, 2011). Rice cultivation approaches, prevailing weed species and their severity of harm, farming practices employed, and climatic conditions of that particular area can all affect how much crop-weed competition reduces rice output (Jabran and Chauhan, 2015). Utami and Purdyaningrum (2012) reported that competition from weeds could decrease rice output by approximately 15-42% and 47-87% for lowland and upland rice, respectively. The literature also showed that crop-weed competition would decline rice seed yields by up to 30-40% in Sri Lanka (Abeysekera, 2001) and 10-35% in Malaysia (Karim et al., 2004). Conversely, weed invasions in Bangladesh decreased seed yields to 70-80% in *aus* rice, 30-40% in T. *aman* rice and 22-36% in *boro* rice (BRRI, 2008).

Weed diversification refers to variations in weed communities that occur in different agro-ecosystems and with various crops. Rice field has diversified weed succession and dissemination mechanisms for cumulative impacts of natural as well as man-made activities (Begum et al., 2008; Uddin et al., 2010), and also for interspecies antagonism between weed and crop and intraspecies antagonism among same weed species (Poggio et al., 2004). Weed species profile can vary from region to region due to seasonal alteration and long-term environmental changes. Matloob et al. (2015) stated that weed diversity of a particular rice field is affected by sunlight, minerals, tillage, water, crop implantation methods and farming practices. Besides, geography, rice cultivation methods, groundwater schemes, crop diversification, soils and atmospheric temperature, tillage, nutrition, rice variety, weed management techniques and interactions between these factors all impact the abundance of weeds in rice fields (Rao et al., 2007). Furthermore, natural resource allocation and their abundance are altered by farming techniques like weed management, fertilization, crop development, and tillage, which have an impact on the profile and geometry of plants (Ahmadvand, 2005; Kraehmer et al., 2016; Lal et al., 2014; Zadeh et al., 2008). In addition, precise assessment of the spatial dispersion trends and abundance of weeds for every region becomes crucial. Therefore, Lass and Callhan (1993) urged developing the relevant charts for weed dispersion and density before executing further initiatives. Moreover, every rice cultivation method possesses a unique weed profile (Korres et al., 2017). Therefore, addressing spatial weed diversity is crucial to improve the effectiveness of weed control techniques.

Survey is a widely used approach to determine the weed divergence in agro-ecosystems (Uddin et al., 2010). A weed control program requires a systematic survey to manage the existing weed concerns within farmland, and survey data is vital for designing problem-based research projects. Mohammaddoust-Chamanabad (2011) also reported that data acquisition, assessment, ratification of

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appropriate actions, and execution of control strategies depending upon collected data are the four basic management approaches relevant to the focus area. Weed composition, abundance, importance and ranking change during the year and year to year in response to the newly executed weed control practices. So, planning and implementing successful weed control strategies requires detailed, precise, and in-depth surveyed information about the types and levels of weed competition in the croplands. Moreover, management approaches may fall to the ground without the capability to portend the succession and distribution of weeds. But, the data on weed composition in rice fields under the investigation area is not available in literature. Besides, this study would help to discover the various troublesome weeds grown in rice fields which can be used to learn about the biology and ecology of that weed types. Additionally, the better weed control strategy we can develop for the upcoming season will depend on how well we understand the features of various weed species. Chauhan and Johnson (2010) stated that knowledge of weed biology and ecology is crucial to developing effective and sustainable weed management tactics. Furthermore, information on leftover weed vegetation as well as their dispersion pattern in this region, would assist in anticipating potential weed challenges and might aid in designing successful weed management techniques for increasing rice productivity. Therefore, the purpose of the recent investigation was to determine the predominant weed flora composition and severity of the prevailing weed flora in a rice field.

II. Materials and Methods

The surveys were performed in Jashore, Bangladesh (latitude: 23°10'10.96" N and longitude: 89°12'49.36" E) from July to December 2021. T. *aman* rice fields were surveyed, covering 3 upazilas, such as Jhikargacha (latitude: 23°06'0.00" N and longitude: 89°07'59.88" E), Monirampur (latitude: 23°01'0.12" N and longitude: 89°13'59.88" E), and Keshabpur (latitude: 22.9042°N and longitude: 89.5667°E). The study area corresponds to calcareous dark grey floodplain soil within the calceric, combosols and gleysols class of High Ganges River Floodplain that falls under the Agro-Ecological Zone-11 (AEZ- 11) (UNDP and FAO, 1988). The soil in the research area had a pH of 8.0 with 2.4% organic matter, making it slightly alkaline. The land type was high to medium high with silty loam in texture.

BRRI dhan72 was used as the planting material and its seedlings were transplanted in fields in 1st week of August. The survey was conducted in 10 randomly selected T. *aman* rice fields within each aforesaid surveyed upazila. Each field was divided into four parts which were considered as replications. The data was collected from fields while the rice plants were 65 days older. The quantitative surveying technique employing a 0.25 m^2 quadrate and 16 samples (excluding canals, pits, and field edge) per each field were considered for the survey following zig-zag pattern. All weeds within the quadrate were classified, numbered, and documented. The weed type that could not be recognized in the rice fields was labelled and transported for subsequent confirmation (Chancellor and Froud-Williams, 1984). The information was simplified into five quantifiable measures: frequency, field uniformity across all fields, density across all fields, density occurrence fields, and relative abundance (Thomas, 1985).

Frequency (F)

The percentage of all the fields studied where a species was present in at least one quadrate was computed as the frequency (F). The frequency (F) score represented the proportion of fields where a species, k, was found in at least one quadrate per field. The following equation was used to calculate F value.

$$F_k = \frac{\sum_{i=0}^{n} Y_i}{n} \times 100$$

Here,

F_k = Frequency of the species K

Y_i = Occurrence (1) or absence (0) of K in the field i

n = Number of total field surveys

Field uniformity (FU)

It represents the sampling sites (4 quadrats for each field) where a species was found as a percentage of all samples. The above value was employed to determine the region where a species was present. The following equation was used to calculate FU value.

$$U_k = \frac{\sum^{n}\sum^{4} X_{ij}}{4n} \times 100$$

Here,
U_k = Field uniformity of the species K
X_{ij}= Occurrence (1) or absence (0) of the species K in quadrate J of the field i
n = Number of fields surveyed.

Density (D)

For every weed species, it is the quantity of individual of a given species for each m^2.

$$D_{ki} = \frac{\sum^{4} Z_j}{n} \times 4$$

Here,

D_{ki} = Density (numbers per m^2) of species k in field i and
Z_j = Number of individuals of each species in quadrate j (quadrate size is 0.25 m^2)

Mean field density (MFD)

The MFD value is the average number of plants for every species per m^2 across all surveyed fields. It is calculated by summing the densities of all the fields (D) for a specific species and dividing by the total number of fields.

$$MFD_k = \frac{\sum^{n} D_{ki}}{n}$$

Here,

MFD_k = Mean field value of species K
D_{ki} = density (individuals per m^2) of species k in field i,
n = Number of all fields surveyed.

Relative abundance (RA):

RA can be described by comparing the overall abundance of each weed to another (Thomas and wise, 1987), assuming that frequency, field uniformity and mean field density value are equally important for describing the relative significance of a weed species. For a species "K", the relative frequency (RF_K), relative field uniformity (RFU_k) and relative mean field density ($RMFD_k$) have to be calculated with the following formula:

Relative frequency for a species K (RF_K) $= \frac{Frequency\ value\ of\ species\ K}{Sum\ of\ frequency\ value\ of\ all\ species} \times 100$

Relative field uniformity for a species K (RFU_k) $= \frac{Field\ uniformity\ value\ of\ species\ K}{Sum\ of\ field\ uniformity\ of\ all\ species} \times 100$

Relative mean field density for a species K ($RMFD_k$) $= \frac{Mean\ field\ density\ value\ of\ species\ K}{Sum\ of\ mean\ field\ density\ of\ all\ species} \times 100$

RA would be estimated using the following equation as mentioned by Thomas (1985):

Relative abundance for species K, RA_k = $RF_k + RFU_k + RMFD_k$.

The total of all species' RA values in an ecosystem is 300.

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III. Results and Discussion

Weed flora taxonomy in T. *aman* Rice fields

Forty six weed species, including 11 types of grass, 7 sedges, 27 broadleaves and one fern were identified in the selected T. *aman* rice fields (Table 01). The number (25) of annual weeds was greater than that of perennial weeds (21). Moreover, annual grass weeds were more dominant in the study area than perennial grass weeds because of improper herbicidal or cultural control measures. The weed species from the study area belonged to 20 different families. Among which *Poaceae* family ranked first with 11 weed species. The *Cyperaceae* family was the second largest family, contributing seven species, followed by *Compositae* and *Commelinaceae,* with 3 species each. The *Amaranthaceae, Leguminosae, Onagraceae, Pontederiaceae, Scrophulariaceae*, and *Solanaceae* represented two weed species each. Each of the other ten families produced one species (Table 01). Together, the *Poaceae* and *Cyperaceae* made up 39.13% of all species. Uddin et al. (2018) identified 22 weed species (five grasses, six sedges and 12 broadleaves) belonging to 12 different families in T. *aman* rice fields under AEZ-9 (Old Brahmaputra Floodplain) where annual grasses were more dominant and abundant than perennial grasses.

Additionally, they also reported that the most dominant families were *Poaceae* (22.45%) and *Cyperaceae* (22.45%), followed by *Commelinaceae* (13.63%). Tshewang et al. (2016) found 27 weed species totalling 10 families, including 13 annual and 14 perennial species, in Bhutan rice fields. According to a study performed in Egypt's rice fields, 71 weeds were documented and the *Poaceae*, *Asteraceae* and *Cyperaceae* families were found to have the highest percentages of weed species (28, 9, and 7%, respectively) (Turki and Sheded, 2002). In general, weed diversity in a particular location is ascertained by different edaphic and biotic components such as soil structure, soil reaction, nutrition, soil water, associated crop plants, weed management approaches, and farm histories, especially within that particular topographical variation which is supported by (Hakim et al., 2010).

Table 01. Weed species observed in T. *aman* rice fields

Local name	English name	Scientific Name	Family name	Life cycle
Grasses				
Durba	Bermuda grass	*Cynodon dactylon* L.	*Poaceae*	P
Shama	Burnyard grass	*Echinochloa crus-galli*	*Poaceae*	A
Khude shama	Jungle grass	*Echinochloa colonum* L.	*Poaceae*	A
Angta	Joint grass	*Panicum distichum* Lam.	*Poaceae*	A
Arail	Swamp rice grass	*Leersia hexandra* Sw.	*Poaceae*	P
Angulee	Crab grass	*Digitaria sanguinalis* L.	*Poaceae*	P
Chela ghash	Sheand grass	*Parapholis incurua* L.	*Poaceae*	A
Gaicha	Knot grass	*Paspalum commersonii*	*Poaceae*	A
Mona ghash	*Thread Sprangletop*	*Leptochloa panicea*	*Poaceae*	A
Sabuj shial leja	*Green foxtail*	*Setaria viridis*	*Poaceae*	A
Chapra	Yard grass	*Eluesine indica* L.	*Poaceae*	A
Sedges				
Mutha	Slendar flat grass	*Cyperus rotundus*	*Cyperaceae*	P
Halde mutha	Yellow nutsedge	*Cyperus esculentus* L.	*Cyperaceae*	P
Joina	Grass like fimbry	*Fimbristylis miliacea* L.	*Cyperaceae*	P
Bara chucha	Rice flat sedge	*Cyperus iria* L.	*Cyperaceae*	P
Pani chaise	Purple spike rush	*Eleocharisatro purpurea*	*Cyperaceae*	P
Sabuj nakful	Small flower umbrella grass	*Cyperus difformis* L.	*Cyperaceae*	P
Matichaize	Tall fringe rush	*Fimbristylis diphylla*	*Cyperaceae*	P
Broadleaves				
Chanchi	Joyweed	*Alternanthera sessilis*	*Amaranthaceae*	A
Malancha	Alligator weed	*Alternanthera philoxeroides*	*Amaranthaceae*	A
Topapana	Water lettuce	*Pistia stratiotes* L.	*Araceae*	P
Azolla	Azolla	*Azolla pinnata* R.Br.	*Azollaceae*	P
Halud nakful	Toothache plant	*Spilanthes acmella* L.	*Compositae*	P
Keshuti	False daisy	*Eclipta alba* Hassk.	*Compositae*	A

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Local name	English name	Scientific Name	Family name	Life cycle
Mikania lata	*Climbing hempweed*	*Mikania scandens*	*Compositae*	P
Kanainala	Spreading dayflower	*Cyanotis axillaris* L.	*Commelinaceae*	A
Kanaibasi	Tropical spiderwort	*Commelina benghalensis*	*Commelinaceae*	A
Monayna	Spreading day flower	*Commelina diffusa*	*Commelinaceae*	A
Kalmilata	Bind weed	*Ipomoea indica* L.	*Convolvulaceae*	A
Bara dudhia	Sneeze Weed	*Euphorbia hirta*	*Euphorbiaceae*	A
Bhatshola	Sola pith plant	*Aeschynomene aspera*	*Leguminosae*	P
Tripotrishak	Creeping trefoil	*Desmodium triflorum*	*Leguminosae*	A
Acidghash	Lowland rotala	*Rotala ramosior* L.	*Lythraceae*	A
Sushni shak	Pepperwort	*Marsilea crenata* Pressl.	*Marsileaceae*	A
Fern	Fern	*Nephrolepis cordifolia*	*Nephrolepidaceae*	P
Panishapla	Waterlily	*Nymphaea nouchali* L.	*Nymphaeaceae*	P
Panilong	Winged water primerose	*Ludwigia hyssopifolia* L.	*Onagraceae*	P
Keshoredam	Water primrose	Ludwigia adscendens	*Onagraceae*	P
Amrulshak	Indian sorrel	*Oxalis europaea* Jord	*Oxalidaceae*	A
Panikachu	Pickerel weed	*Monochoria vaginalis*	*Pontederiaceae*	P
Kachuripana	Water hyacinth	*Eichhornia Crassipes*	*Pontederiaceae*	P
Panimarich	False pimpernel	*Lindernia hysopioides* L.	*Scrophulariaceae*	A
Bacopa	Sparrow false pimpernel	*Lindernia antipoda* L.	*Scrophulariaceae*	A
Tit begun	*Devil's fig*	*Solanum torvum*	*Solanaceae*	A
Foska begun	Clamy ground cherry	*Physalis minima*	*Solanaceae*	A
Jhilmorich	Gooseweed	*Sphenoclea zeylancia* L.	*Sphenocleaceae*	A

Here, A=Annual; P=Perennial

Species Frequency (F)

Echinochloa crusgalli was the most prevalent and frequent (F: 100%) weed species among the grasses (Table 02). The next occurred grasses in> 50% frequencies in descending order were *Digitaria sanguinalis, Echinochloa colonum* and *Panicum distichum*. *Fimbristylis milicaea* (F: 100%) was the most prevalent weed species among the sedges in frequency, followed by *Eleocharisatro purpurea* and *Cyperus difformis* which occurred in >50% of fields. *Monochoria vaginalis* (F: 100%) appeared as the most frequent weed among the broadleaves. In addition, the broadleaf weeds that had frequencies > 50% were *Commelina diffusa, Ludwigia hyssopifolia, Azolla pinnata, Ludwigia adscendens, Lindernia hysopioides,* and *Lindernia antipoda*. Two grasses *Parapholis incurua* and *Setaria viridis;* two sedges *Cyperus rotundus* and *Fimbristylis diphylla;* two broadleaves *Eclipta alba* and *Spilanthes acmella* were the equally least frequent weed species in the rice fields (Table 02). Uddin et al. (2018) revealed that the weed flora that occurred in frequencies ≥ 60% under AEZ-9 in Bangladesh were *Echinochloa crusgalli* from grass weeds; *Fimbristylis miliacea* and *Cyperus difformis* from sedge weeds; and *Polygonum orientale*, *Alternanthera philoxeroides*, *Hedyotis corymbosa*, *Marsilea crenata*, and *Monochoria vaginalis* from broadleaves. Four weed species, such as *Echinochloa crusgalli*, *Fimbristylis miliacea, Cyperus difformis* and *Monochoria vaginalis* were similar to our findings. From Iran, Golmohammadi et al. (2018) reported that among the grass weeds, *Echinochloa crusgalli* (F: 89.8%), *Paspalum distichum* (F: 79.42%) and *Echinochloa oryzoides* (F: 60.29%); among the sedges *Cyperus difformis* (F: 56.5%), *Cyperus serotinus* (F: 34.5%) and *Cyperus esculentus* (F: 31.6%); and among broad-leaved weeds, *Eclipta prostrate* (F: 49.5%), *Sagittaria trifolia,* (F; 31.6%), and *Alisma plantago-aquatica* (F: 28.7%) were the most frequent weed species. However, *Echinochloa* spp., once the rice is sown or transplanted, may arise right away to combat strongly with rice plants for minerals, habitat, sunlight and moisture, which is supported by Yaghoubi and Farahpour (2013).

Field Uniformity (FU)

A field's uniformity is a numerical indicator of how widely a particular weed species has spread in a specific field. For example, *Echinochloa crussgalli* had the greatest FU (96.2%) of all grasses, followed by *Echinochloa colona* (92.5%), whereas *Setaria viridis* had the least FU (5.5%) followed by *Parapholis incurua* (7.4%) and *Leersia hexandra* (18.5%) (Table 02). Among sedge weeds, *Fimbristylis miliacea* had the greatest FU (85.1%), followed by *Eleocharisatro purpurea* (80.78%) and *Cyperus difformis* (70.3%), whereas rest of the species had FU from 6.57 to 24.78%. Among broadleaf weed species,

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Monochoria vaginalis showed the highest field uniformity (90.75%) followed by *Lindernia hysopioides* (80.47%). The weed species with > 50% uniformity were *Lindernia antipoda, Ludwigia adscendens, Ludwigia hyssopifolia, and Commelina benghalensis* but rest of the species represented 6.2 to 32.4% (Table 02). In contrast, the highest uniform occurrence was observed in *Ludwigia hyssopifolia* followed by *Alternanthera sessilis*, *Polygonum orientale*, *Fimbristylis miliacea* and *Echinochloa crussgalli* in T. *aman* rice fields under AEZ-9 in Bangladesh (Uddin et al., 2018). According to Uddin et al. (2010), *C. aromaticus* and *C. compressus* produced the greatest FU scores, 16.7% and 43.6%, respectively.

Mean field density

In grass weeds, the highest density (29.11 m^{-2}) was observed in *Echinochloa crus-galli* followed by *Echinochloa colonum* (8.41 m^{-2}) (Table 02). *Parapholis incurua* and *Setaria viridis* had the lowest density with 0.15 plants m^{-2}. In sedge weeds, *Fimbristylis miliacea* had a density of 14.81 plants m^{-2} followed by *Eleocharisatro purpurea,* and *Fimbristylis diphylla* had the lowest density with 0.07 plants m^{-2}. In broadleaves, *Monochoria vaginalis* appeared with the highest density (6.74 plants m^{-2}) followed by *Ludwigia hyssopifolia* (6.07 plants m^{-2}), whereas rest of the weeds ranged from 0.22 to 4.52 plants m^{-2} (Table 02). Each weed had diversified density which is a crucial determinant for adopting any weed control option. Besides, weed flora with the largest frequency, field uniformity and mean field density were more challenging to manage. So, they must be taken under regular inspection. Conversely, weed species with frequency <50%, field uniformity <30%, and MFD<4 plants m^{-2} might show less competition with rice plants or be managed through recent weed control practices in the studied region. The management of weed species depends on the extent of weed density. The present result is different from Uddin et al. (2018) that *Ludwigia hyssopifolia* had the highest density of 17.6 plants m^{-2} under AEZ-9 in Bangladesh, followed by *Fimbristylis miliacea* (11.4 plants m^{-2}). In addition, Golmohammadi et al. (2018) from Iran also reported that the most densely populated weeds were *C. difformis* (9 plants m^{-2}) followed by *P. distichum* (8 plants m^{-2}), *E. crus-galli* (5 plants m^{-2}), *C. esculentus* (5 plants m^{-2}), *E. prostrate* (2.275 plants m^{-2}) and *Monochoria vaginalis* (2.969 plants m^{-2}), whereas rest of the species ranged from 0.003 to 1.91 plants per square meter. The reason for this migration from broadleaves and sedges to competitive grasses was the persistent use of herbicides in weed management activities and it is supported by Azmi and Baki (1995) and Ho (1998).

Relative Abundance

The results showed that *Echinochloa crus- galli* (34.41) produced the largest RA of all weeds in the studied location, followed by *Fimbristylis miliacea* (22.14) (Table 02). The highest abundant weed from grasses next to *Echinochloa crusgalli,* was *Echinochloa colonum* followed by *Digitaria sanguinalis and Panicum distichum*. Among sedge weeds, the largest RA (22.14) was found in *Fimbristylis miliaceae* followed by *Eleocharisatro purpurea* (12.96) and *Cyperus difformis* (9.88), whereas *Monochoria vaginalis* (16.04) was found to be the most abundant among broadleaves followed by *Lindernia hysopioides* (12.59)*, Ludwigia hyssopifolia* (12.09) and *Lindernia antipoda* (10.44) (Table 02). RA reveals an insight into the entire weed burden a species poses. The ten most abundant weed species in decreasing order were *Echinochloa crus-galli* (RA: 34.41), *Fimbristylis miliacea* (RA: 22.14), *Echinochloa colona* (RA: 16.56), *Monochoria vaginalis* (RA: 16.04)*, Eleocharisatro purpurea* (RA: 12.96)*, Lindernia hysopioides* (RA: 12.59)*, Ludwigia hyssopifolia* (RA: 12.09)*, Digitaria sanguinalis* (RA: 11.05)*, Lindernia antipoda* (RA: 10.44), *and Cyperus difformis* (RA: 9.88) (Figure 01).

Most of the weeds in the present survey were perennial types (Table 01), While Hakim et al. (2013) from Malaysia found annual in nature. Moreover, broadleaves had higher abundance value (150.3) than grasses (93.6) and sedges (56.1) (Table 02) and this is consistent with the results achieved by Golmohammadi et al. (2018). The repeated puddling technique employed in the paddy field may have contributed to the current finding, which is also endorsed by Moody (1982). According to F, FU, and MFD, weed species were ranked differently in the current lists; nonetheless, the higher RA score for a given weed type corresponds to that type's higher values for each of those metrics (Table 02). Besides, *Echinochloa crussgalli, Fimbristylis miliacea, Echinochloa colonum* and *Monochoria vaginalis* appeared as the most abundant weeds regardless of F, FU and MDF. This finding suggests that *Echinochloa crussgalli, Fimbristylis miliacea, Echinochloa colonum* and *Monochoria vaginalis* are the greatest troublesome weeds of rice fields in Jashore district. The one more grass, *Digitaria sanguinalis*; two sedges *Cyperus difformis*, *Eleocharisatro purpurea;* and three broadleaved *Lindernia antipoda, Ludwigia hyssopifolia and Lindernia hysopioides* were similarly significant and plentiful weeds having frequency ≥ 70% and RA value ≥8.

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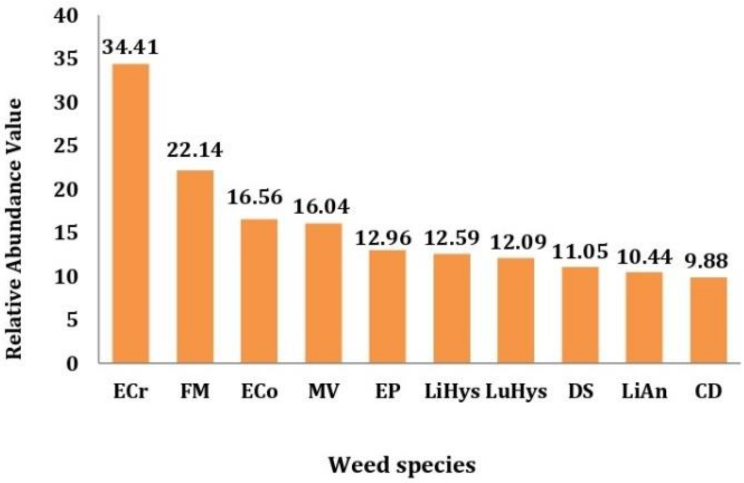

Figure 01. Top 10 abundant weed flora identified in Jashore District, Bangladesh

ECr=*Echinochloa crus-galli*; FM=*Fimbristylish miliacea*; Eco= *Echinochloa colona*; MV=*Monochoria vaginalis;* EP=*Eleocharisatro purpurea;* LiHys=*Lindernia hysopioides;* LuHys=*Ludwigia hyssopifolia;* DS=*Digitaria sanguinalis;* LiAn=*Lindernia antipoda* and CD=*Cyperus difformis*

Hakim et al. (2013) stated that most weeds with the greatest F, FU and MFD are challenging to eradicate. The troublesome weeds' RA in the rice ecosystems confirms this. The current outcome may be the consequence of repeated rice farming and poor weed control, which is one of the causes of the emergence of these species as the dominant one. According to Uddin et al. (2018), the five most abundant weeds under the AEZ-9 in Bangladesh with respect to RA value were *Ludwigia hyssopifolia* (35.1), *Alternanthera sessili* (24.5), *Polygonum orientale* (23.1), *Fimbristylis miliacea* (22.3), and *Hedyotis corymbosa* (19.1), with the remaining species having 175.9 RA value. In rice fields, 17 weed species were found by Kandibane et al. (2007), with *Echinochloa colona*, *Cyperus rotundus*, *Cyperus iria*, *Cyperus difformis*, *Panicum repens*, and *Brachiaria mutica* being the most prevalent. Golmohammadi et al. (2018) reported that the most significant weed species with more RA scores in the rice fields of Guilan, Iran, were *Echinochloa crus-galli* (31.18), *Panicum distichum* (29.28), *Cyperus difformis* (25.56), *Eclipta prostrate* (13.7), *Echinochloa oryzoides* (13.28), and *Cyperus esculentus* (13.25). The above discussion revealed that *Echinochloa crus-galli* is the most abundant and dominant species in rice fields. The cause might be due to mimic nature of *Echinochloa crus-galli* to rice plants which helps them to escape management approaches and become dominant to compete with the rice plants throughout the growing season. It is supported by Rao and Moody (1988).

Table 02. Mean field density, frequency, field uniformity and relative abundance of weed in T. *aman* rice fields

Local name	Scientific Name	F	FU	MFD	RA
Grasses					
Durba	*Cynodon dactylon* L.	44.44	25.9	0.56	4.15
Shama	*Echinochloa crus-galli* L.	100.00	96.2	29.11	34.41
Khude shama	*Echinochloa colonum* L.	77.77	92.5	8.41	16.56
Angta	*Panicum distichum* Lam.	66.66	40.3	3.78	8.70
Arail	*Leersia hexandra* Sw.	44.44	18.5	0.85	3.87
Angulee	*Digitaria sanguinalis* L.	88.88	48.1	4.85	11.05
Chela ghash	*Parapholis incurua* L.	22.22	7.4	0.15	1.58
Gaicha	*Paspalum commersonii*	44.44	20.41	0.44	3.68
Mona ghash	*Leptochloa panacea*	44.44	21.23	0.56	3.82
Sabuj shial leja	*Setaria viridis*	22.22	5.5	0.15	1.45
Chapra	*Eluesine indica* L.	44.44	20.56	1.22	4.31
Sedges					
Mutha	*Cyperus rotundus*	22.22	11.1	0.67	2.26
Halde mutha	*Cyperus esculentus* L.	44.44	10.36	0.26	2.82
Joina	*Fimbristylis miliacea* L.	100.00	85.1	14.81	22.14
Bara chucha	*Cyperus iria* L.	44.44	24.78	1.18	4.58
Pani chaise	*Eleocharisatro purpurea*	88.88	80.78	4.37	12.96

Local name	Scientific Name	F	FU	MFD	RA
Sabuj nakful	*Cyperus difformis* L.	77.77	70.3	2.04	9.88
Matichaize	*Fimbristylis diphylla*	22.22	6.57	0.07	1.46
Broadleaves					
Chanchi	*Alternanthera sessilis*	44.44	26.35	1.18	4.69
Malancha	*Alternanthera philoxeroides*	44.44	30.45	1.81	5.49
Topapana	*Pistia stratiotes* L.	33.33	9.1	1.07	2.92
Azolla	*Azolla pinnata* R.Br.	66.66	13.5	3.48	6.58
Halud nakful	*Spilanthes acmella* L.	22.22	6.2	0.22	1.56
Keshuti	*Eclipta alba* Hassk.	22.22	12.3	0.22	1.99
Mikania lata	*Mikania scandens*	33.33	10.9	1.15	3.10
Kanainala	*Cyanotis axillaris* L.	33.33	10.6	0.22	2.34
Kanaibasi	*Commelina benghalensis* L.	44.44	51.8	2.04	7.16
Monayna	*Commelina diffusa*	88.88	32.4	0.67	6.59
Kalmilata	*Ipomoea indica* L.	44.44	30.67	2.55	6.10
Bara dudhia	*Euphorbia hirta*	44.44	15.45	0.78	3.60
Bhatshola	*Aeschynomene aspera*	44.44	18.5	1.15	4.11
Tripotrishak	*Desmodium triflorum*	33.33	9.38	0.33	2.34
Acidghash	*Rotala ramosior* L.	33.33	13.87	0.22	2.57
Sushni shak	*Marsilea crenata* Pressl.	44.44	22.36	0.82	4.11
Fern	*Nephrolepis cordifolia*	33.33	17.51	0.11	2.73
Panishapla	*Nymphaea nouchali* L.	33.33	16.24	0.70	3.12
Panilong	*Ludwigia hyssopifolia*	77.77	55.63	6.07	12.09
Keshoredam	*Ludwigia adscendens*	66.66	50.45	1.48	7.57
Amrulshak	*Oxalis europaea* Jord	44.44	19.45	3.63	6.17
Panikachu	*Monochoria vaginalis*	100.00	90.75	6.74	16.04
Kachuripana	*Eichhornia Crassipes*	44.44	7.55	0.74	3.01
Panimarich	*Lindernia hysopioides*	77.77	80.47	4.52	12.59
Bacopa	*Lindernia antipoda* L.	77.77	53.68	4.19	10.44
Tit begun	*Solanum torvum*	44.44	10.9	1.41	3.78
Foska begun	*Physalis minima*	44.44	12.5	2.78	5.00
Jhilmorich	*Sphenoclea zeylancia*	33.33	8.93	0.59	2.52

Here, F=Frequency; FU=Field Uniformity; MFD=Mean Field Density; RA=Relative Abundance

IV. Conclusion

The present study revealed that *Poaceae* was the most dominant family, followed by *Cyperaceae*. Annual weeds were dominant over perennial weeds and broadleaves were predominant over grass weeds and sedge weeds. Irrespective of frequency, field uniformity, and density, the most abundant weed species were *Echinochloa crussgalli, Fimbristylis miliacea, Echinochloa colonum* and *Monochoria vaginalis* out of 10 abundant weed species. So, the management strategies should be based on this result to control these weeds more effectively. Besides, other weeds such as *Eleocharisatro purpurea, Lindernia hysopioides, Ludwigia hyssopifolia, Digitaria sanguinalis, Lindernia antipoda* and *Cyperus difformis* may have the chance to emerge as the top abundant and dominant weed species in the T. *aman* rice fields because of any change in management practices and cultivation procedures. Additionally, frequent survey activities are needed to predict potential troublesome weeds and their shifting pattern and focus research on newer and advanced management approaches.

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