

## Study on Spikelet Morphology of Some Indian Grasses (Poaceae)

Sujit Mondal, Aaratrik Pal and Monoranjan Chowdhury\*

Taxonomy of Angiosperms and Biosystematics Laboratory, Department of Botany, University of North Bengal, Siliguri-734 013, Darjeeling, West Bengal, India

### Abstract

Poaceae (Graminae) is one of the largest vascular flowering plant family that includes many economically valuable food crops that cultivated in different parts of the World. Grasses are most common floral component of all kind of vegetation and they grow in marshy lowland to higher altitudes. Identification at the species level becomes extremely difficult for grasses and only the revelation of detailed spikelet features can be a strong tool to provide a satisfactory result. Present work studied detailed morphology of various parts of spikelet of some grass from sub-Himalayan West Bengal along with their suitable illustrations.

**Keywords:** Spikelet, Glumes, lodicule, Poaceae

### Article info

Received 10 May 2020

Revised 15 October 2020

Accepted 11 December 2020

### Introduction

The grass family, Poaceae is the fourth largest angiosperm family having about 12000 species under 780 genera (Watson & Dallwitz, 1992; Clayton & Renvoize, 1986; Christenhusz & Byng, 2016) which are economically, ecologically, and evolutionarily successful species rich groups in the world (Calderon & Thomas, 1973). In India Poaceae is the largest family which comprises about 1300 species belonging to 268 genera (Karthikeyan *et al.*, 1989; Moulik, 1997). About 430 grass species belongs to 15 genera are strictly endemic to India and 40% of them are concentrated in Peninsular India (Jain, 1986). There are two are monotypic genera and species of 13 genera are strictly restricted to Peninsular India (Kiran Raj *et al.* 2003). Since the dawn of human civilization, the value of the grasses to the mankind has been recognised. The members of this family are present in all the suitable habitats for their growth (Mitra & Mukherjee, 2015). Noltie (1994) described 18 genera with several species which provided us a broad idea about Poaceae from Eastern Himalayan region. But the spikelet structure is not previously described in-detail. Prain (1903) described 405 species with 133 genera from undivided West Bengal. Pal *et al.* (1991) and Pal (2010) described 34 species of Bengal's grasses in his book "*Banglar Ghas o Bash*". This book plays

an instrumental role in the identification of the family Poaceae.

### Materials and Methods

A thorough survey of the Terai Duars areas was made during mid-February to mid-June for the collection of grasses at their flowering stage (2018-2020). The specimens were collected and temporarily preserved in large polythene bags with mouths being kept tied to prevent the desiccation. After return to the laboratory, the specimens were cleaned and pressed within old newspaper under heavy wooden herbarium press. After proper drying of specimens were poisoned and mounted on herbarium sheets to prepared voucher specimens (Paul *et al.*, 2020). Identification of all the collected specimens was done in the Taxonomy of Angiosperms and Biosystematics Lab., Department of Botany, North Bengal University using available literature and matching with the available predetermined specimen in the NBU Herbarium and voucher specimens were deposited in NBU herbarium. Fresh spikelet of all the collected specimens were dissected and observed under microscope critically. Each part of spikelet was drawn and measurement also recorded.

\* **Correspondence** - mono\_malda@yahoo.co.in

**Result and Discussion**

Spikelet morph-taxonomical study on commonly available grass species was done. All the 14 selected species are representative of six different tribes

(table 1). The parts of spikelets and their peculiarities are clearly showing in Fig 1 and 2. The studied morphological feature are quite useful for the definite identification of grass species and for easy identification a genus key is provided.

**Key to the genera**

1a. Cultivated, annual .....2  
 1b. Wild, annual or perennial .....3  
 2a. Glume 1 & 2 reduced to minute swellings, spikelet sometimes subtended by glume like sterile floret, palea 1-keeled ... *Oryza*  
 2b. Glume 1 & 2 not reduced to minute, inflorescence spike like, glume hairy ..... *Triticum*  
 3a. Spikelets arranged in racemes .....4  
 3b. Spikelets not arranged in racemes .....7  
 4a. Racemes arranged in 1 row .....*Axonopus*  
 4b. Racemes arranged in more than I row .....5  
 5a. Raceme usually in 3 or more rows, with spikelet inserted singly or in pairs either side of rachis midrib ..... *Paspalum*  
 5b. Spikelets not inserted singly or in pairs either side of rachis midrib .....6  
 6a. Raceme narrow; grain oblong narrowly lanceolate: palea narrowly winged .....*Eleusine*  
 6b. Racemes usually under 2 cm .....*Echinochloa*  
 7a. Glumes long-aristate bristle-like, sticky or hispid.....*Oplismenus*  
 7b. Glumes not long-aristate bristle-like.....8  
 8a. Spikelet whitish or flushed purplish-pink .....*Eragrostis*  
 8b. Spikelet not whitish or flushed purplish-pink .....9  
 9a. Spikelet golden to reddish brown below, glabrous .....*Saccharum*  
 9b. Spikelet not whitish flushed or purplish-pink .....10  
 10a. Spikelets with awn .....*Chrysopogon*  
 10b. Spikelet without awn .....11  
 11a. Floret single ..... *Cynodon*  
 11b. Florets many .....12  
 12a. Hairs from callus or back to the glume .....*Imperata*  
 12b. Lateral veins of lower lemma lacking spicules near apex .....*Digitaria*

**Table 1** Collected grasses are belonging to the six tribes of Gramineae

Tribe	Taxa
Paniceae	<i>Axonopus compressus</i> , <i>Digitaria ciliaris</i> , <i>Echinochloa colona</i> , <i>Oplismenus burmannii</i> , <i>Oplismenus compositus</i> , <i>Paspalum scrobiculateum</i>
Andropogoneae	<i>Chrysopogon acciculatum</i> , <i>Imperata cylindrica</i> , <i>saccharum spontanum</i>
Cynodonteae	<i>Cynodon dactylon</i>
Eragrostideae	<i>Eleusine indica</i> , <i>Eragrostis uniloides</i>
Oryzeae	<i>Oryza sativa</i>
Triticeae	<i>Triticum aestivum</i>

*Axonopus compressus* (Swatz) P. Beauvois, Ess. Agrost. 12, 154. 1678. Bor Grass. Ind 27. 1960. *Millius compressus* Sw., Prodr. Veg. Ind. Oec. 24. 1788; Noltie, Fl. Bhutan 3(2):717. 2000. "**Choto chepti (Beng)**".

Spikelets 2–2.5 mm. Glumes 2–2.5 × 0.8–1 mm, oblong, acuminate, back flat, veins appressed hairy, with long, woolly hairs on incurved sides below and at truncate base: lower lemma 18–2.2 × 0.7–0.9 mm, oblong lanceolate, acuminate to apiculate, back 4 veined, flat margins incurved: upper lemma pale green, 1.6–1.7 × 0.8–1 mm. compressed, oblong-elliptic, blunt, with apical cilia, crustaceous palea 1.5–1.6 × 0.7–0.8 mm, similar to palea, but glabrous, lodicules 2; stamens 3. Styles 2, free: stigmas plumose.

*Specimen cited:* Mahananda Wild Life Sanctuary (MWLS), Mondal et al. 006. 23.04.2019

*Chrysopogon aciculatus* (Retzius) Trinius, Fund. Agrost. 188. 182; Ohwi in Act. Phytotaxa Geobot. 11: 162. 1942. *Andropogon aciculatus* Retz., obs. Bot. 5. 1789; Hook. f. Fl. Brit. Ind. 7: 188. 1986; Prain, Beng Pl. 2. 1205. 1903. Noltie, Fl. Bhutan 3(2):791. 2000.

Sessile spikelet 31–4 mm; callus short hairs golden the longest 0.5–0.9 mm: glume membranous, the lower 3.1–3.8 0.7 mm, narrowly oblong lanceolate, apex bidenticulate back not veined, keels tuberculate - hispid above: upper glume narrowly lanceolate, apex mucronulate keel minutely ciliate above margins widely hyaline; lower lemma 2.5–3 mm. linear-lanceolate, acute; palea 16–1.8 mm. oblong, rounded often absent: upper lemma 2.2–2.9 mm, awn 3.5–5.7 mm; anthers 1.4 mm, spikelets subequal, 4.6–5.7 mm: lower glume 4.5–5.7 mm, narrowly oblong lanceolate. acuminate, midrib minutely hispid above, keels smooth upper glume 3.8–4.7 mm, narrowly oblong. minutely apiculate, margins ciliate: palea 1.4–2.1 mm, linear, acute; upper lemma similar to lower; anthers 2 mm pedicels subequal, 2–3.8 mm more face concave, glabrous. Caryopsis linear 0.2–0.4 mm long

*Specimen cited:* Mahananda Wild Life Sanctuary (MWLS), Mondal et al. 001 dated 17.03.2019.

*Cynodon dactylon* (Linnaeus) Persoon, Syn. Pl. 1: 85. 1805; Hooker f., Fl. Brit. Ind. 7: 288. 1896; Bor., Grass. Ind. 469, f. 52. 1960; Noltie, Fl. Bhutan 3(2): 678 2000. *Panicum dactylon* L., Sp. Pl. 58. 1753. "**Durba ghas**"

Spikelets 1.9–2.7 mm. Lower glume 1–1.9 mm. subacute, each half 0.2–0.3 mm, keel minutely serrate: upper glume 1–2.2, each half 0.2–0.3 mm wide, lemma 1.7–2.5 mm, each half semi-lanceolate, acute, 0.6–0.8 mm wide, keel ciliate, stopping just below apex, Palea 1.5–2.0 × 0.3–0.5 mm; anthers 1.1 mm. Vestigial rachilla 0.5–1.2 mm, so sometimes slightly widened at apex. Stamens 3, Caryopsis oblong + 0.15 cm long brown

*Specimen cited:* Buxa Tiger Reserve. Mondal et al. 22. dated 12.04.2019

*Digitaria ciliaris* (Retzius) Koeler, Deser Gram, 27. 1802; Noltie, Fl. Bhutan 3(2):728. 2000. *Panicum ciliare* Retzius, Obs. Bot 4: 16 1786. *Digitaria sanguinalis* Scopoli var. *ciliaris* sensu Prain, Beng Pl. 2:1181, 1903.

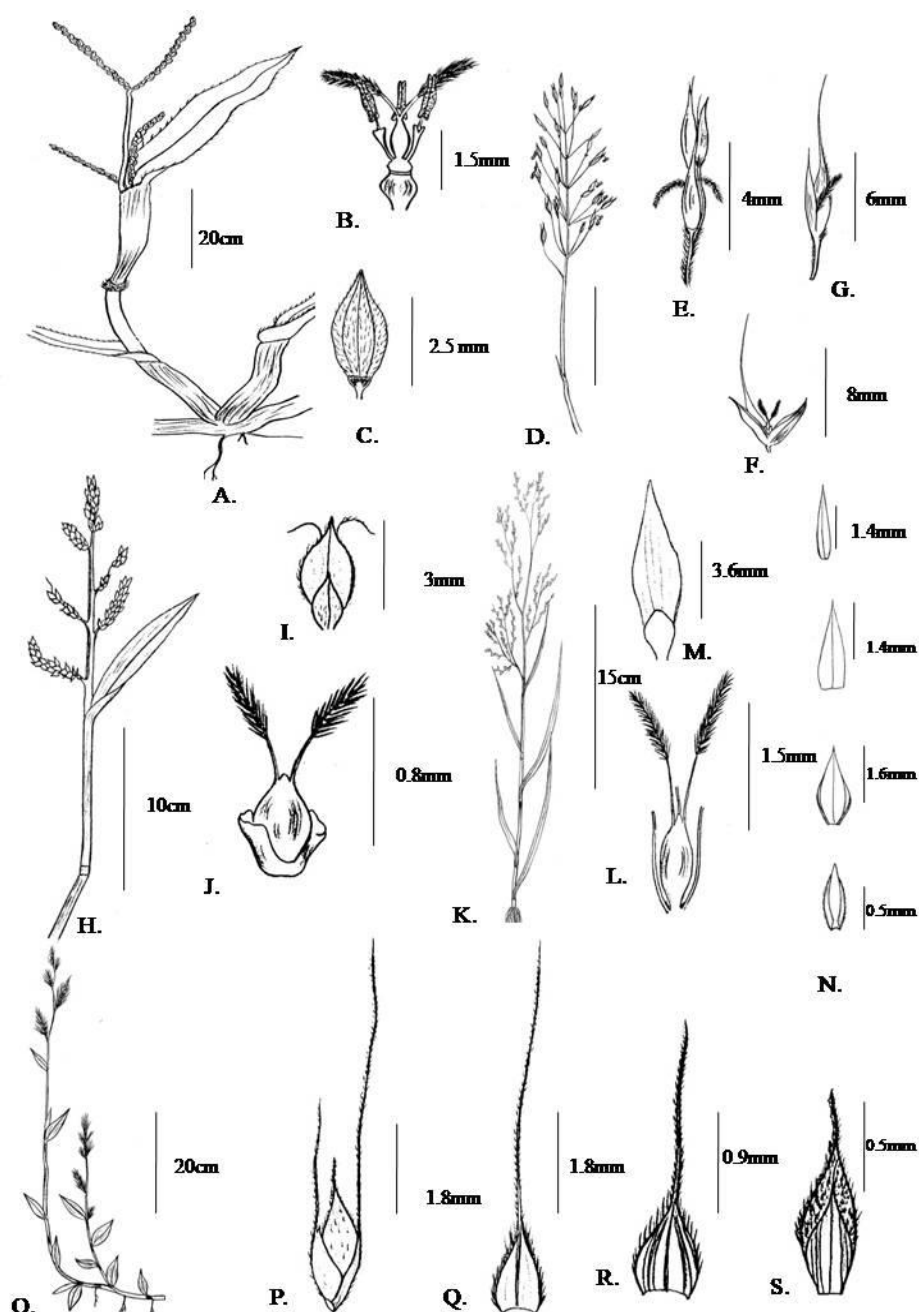
Inflorescence axis 0.8–1.3 cm. Racemes 3–6, digitate or lower 2–3 slightly distant, the lowest 25–10 cm; rachis flattened winged, margins hispid. Spikelets paired, unequal pedicellate. 2.8–3.4 × 0.8–1 mm, lanceolate, acute. Lower glume small, 0.25–0.4 mm, triangular, glabrous: upper glume 1.5–1.8 0.4–0.5 mm, lanceolate, acute, 3-veined, margins fong - ciliate. Lower lemma equaling spikelet, 2.8–3.4 × 0.8 – 1 mm. lanceolate, acuminate, 5 veined, outer 2 pairs close to margins, inter nerve space next to midrib broad, appressed long-hairy between outer veins. upper floret lemma cream-coloured. 2.6–3.1 mm, narrowly oblong lanceolate, acuminate: palea 2.5–3 mm: anthers 0.9 mm. Stamens 3. Caryopsis +0.2 cm long.

*Specimen cited:* Buxa Tiger Reserve, Mondal et al. 03, dated 21.03. 2020.

*Echinochola colona* (Linnaeus) Link, Enum. Hort: Berol. 2: 209. 1833. Haines, Bot. Bihar Or. Pr 5: 997. 1924, Bor, Grass. Cey. Ind and Pak. 308, 1960. Noltie, Fl. Bhutan 3(2):702. 2000. *Panicum colonum* U. Syst. Nat. Ed. 10(2): 870. 1759. Hook. f., Fl. Brit. Ind. 7:32. 1896; Prain, Beng Pl. 2:1177. 1903.

Inflorescence 4.5–11 cm; raceme suberect, all except uppermost rather distant, the lowest 12.2 cm, axis straight, minutely hispid, sometimes also with long cilia. Spikelet 25–3 mm. Lower 14–15 mm. ovate, acuminate, shortly cuspidate, 5–8 veined Lower floret lemma 22–29 mm, oval, acuminate, 7-veined; palea 1.8–2.2 × 0.8–1 mm, oblong-elliptic. Upper floret lemma 19–24 × 1–1.5 mm, narrowly elliptic, apiculate 0.2 mm, polycab 16–2 × 1.3 mm, anthers 0.8 mm.

*Specimen cited:* NBU campus. Mondal et al dated 18.03.2020.



**Fig. 1:** A-C. *Axonopus compressus*, A. habit, B. stamen and pistil C. spikelet; D-G. *Cymbopogon pendulus*, D. habit, E. spikelet, F & G. female flower; H-J. *Echinochloa colona*, H. habit, I. spikelet, J. pistil; K-N. *Eragrostis unioloides*, K. habit, L. pistil, M. spikelet, N. glumes; O-S. *Oplismenus burmannii*, O. habit, P. spikelet, Q. lower glume, R. upper glume, S. lower lemma.

*Eragrostis unioloides* (Retzius) Nees ex Steudel, Syn. Pl. Glum. 264. 1854; Owin, Bot. Mag. Tokyo 55: 275. 1941; Noltie, Fl. Bhutan 3(2): 663. 2000. *Poa unioloides* Retz., Obs. Bot. 5: 19. 1789. Inflorescence 3.5–20 × 1–6 cm. cylindric, moderately dense. branches single, ascending, aglandular, under 10 mm. Spikelets whitish purplish-pink 52–14 × 23–32 mm, lateral veins of lemmas raised so spikelets rather flat in cross section, florets 19–69, glumes, lemmas and palea

deciduous from base upwards, Lower glume 1.4–1.6 × 0.4–0.5 mm lanceolate, acuminate, upper glume 1.4–22 × 0.6–0.8 mm, oblong-lanceolate, subacute Lower floret: lemma 1.4–2.3 × 0.7–1.2 mm, oblong lanceolate ovate, shortly acuminate, surface papillose, lateral veins conspicuously raised, palea 14–18 × 0.6–0.9 mm, narrowly elliptic, truncate keels hispid; anthers 0.2–0.5 mm: grains 0.6–0.7 × 0.3–0.5 mm, oblong-elliptic. smooth, slightly compressed in sections.

*Specimen cited:* Gurumara National Park. Mondal et al 07 dated 03.04.2019.

*Elusine indica* (Linnaeus) Gaertner, Fruct. 1: 8. 1789; Hook. f., Fl. Brit Ind. 7: 293. 1896: Ohwi, Bot. Mag. Tokyo 55: 312. 1941: Bor, Grass. Ind. 495. 1960; Noltie, Fl Bhutan 3(2):667-668. 2000. *Cynosurus indicus* L., Sp. Pl. 72 1753.

Spikelets 2–5 mm long, 3–6 flowered, densely imbricate in 2 rows, pointing upward at an acute angle with the rachis. Glumes membranous, unequal: lower oblong-ovate or oblong, subacute, the lowest 3–3.6 mm long, palea not winged on the keels. Caryopsis oblong, obtuse trigonous.

*Specimen cited:* NBU campus, Mondal et. al. 06 dated 01.04.2020

*Imperata cylindrica* (L.) Rausch., Nom. Bot ed. 3: 10. 1797, Bor, Grass 169 1960: Recder, Tourn. Arm. Arb. 29: 327. 1948; Hara, Fl. E Himl. 366.1966; Noltie, Fl. Bhutan 3(2):770 – 771. 2000. *Lagurus cylindricus* L., Syst. Nat. Ed. 10 & 2 878.1759. **“Kush”**

Inflorescence 3–11 cm. Shorter pedicillated spikelet 25–36 mm: lower glume 22–3mm oblong-lanceolate, rounded on back apex subtruncate-ciliate, 6 ribbed, upper glume longer. 25–3.6 mm. lanceolate, conduplicate, hyaline, margins minutely, acuminate upper lemma 0.6–13 mm, oblong to lanceolate, palea 0.6 × 0.8–14 mm, apex blunt denticulate, pedicel 0.4–0.9 mm, pedicelled spikelet similar, but glume equal; pedicel 1.2–2.5 mm. Anther 22–20 mm. orange.

*Specimen cited:* NBU campus, Mondal et. al. 013. dated 20.04.2020.

*Oplismenus burmannii* (Retzius) P. Beauvois, Ess. Agrost. 54, 168, 169. 1812: Hook. f., Fl. Brit. Ind. 7: 68. 1896; Jansen, Reinwardtia 2.2: 312. 1955; Bor, Grass. Ind. 317. 1960; Noltie, Fl. Bhutan 3(2):686 - 687. 2000. *Panicum burman* Retz, Obs, Bot 3: 10. 1783.

Inflorescence 3–9 cm, axis flexuous, triquetrous, angles ciliate; racemes 5–9, dense the lowest 1–15 cm, axis bearing long cilia Spikelets 2.4–3mm. Lower glume 7–22 × 0.7 mm. lanceolate, narrowly to blunt apex, 3-veined, margins densely ciliate awn 71–12–3 mm. subterminal, minutely antrosely scabrid apex, 5 veined, margins densely ciliate back hairy, awn 34–5 mm Lower floret: lemma 2.4–3 × 0.9–1.1 mm, lanceolate, acuminate, long and short hairy on upperpart of margins 7 veined, awn 0.4–0.9 mm, palea usually absent or linear oblanceolate 21–0.3 mm Upper floret lemma 2.2–2.6 × 0.7 –0.9 mm narrowly lanceolate, acute palea 2–2.4×0.6–0.8 mm; anthers 0.6–1.1 mm.

*Specimen cited:* NBU campus, Mondal et. al. 08 dated 05.04.2019

*Oplismenus compositus* (L.) P. Beauvois, Ess. Agrost. 54, 168. 169. 1812, Hook. f., Fl. Brit. Ind. 7: 66. 1896: Ohwi, Act. Phytotax. Geobot 11 35. 1942, 279, 1948; Jansen, Reinwardtia 22: 311. 1953: Bor, Grass. Ind. 317. 1960; Hara, Fl. E. Himl. 369.1966; Noltie, Fl. Bhutan 3(2):717. 2000. *Panicum compositum* L., Sp. Pl. 1:57. 1753.

Inflorescence 12–23 cm, axis stout, glabrous: racemes 5–10, the lowest 3.7–8 cm, axis triquetrous glabrous or very shortly hairy. Spikelets 3.7–4mm. Lower glume 3.3–3.5 × 1.2–15 mm. lanceolate, tapered upward, sparsely hairy near margins, 5 veined, awn 6–84 mm, upper glume 2.6 –3.2 × 1.3 – 15 mm elliptic acute, hairy near margins or sub glabrous, 7 veined, awn 0.8–5.5 mm 5.5 mm. Lower floret lemma 3.4–3.6 mm, broadly lanceolate, bluntly acuminate, hairy on upper part of margins, 9 veined: palea usually absent or linear-lanceolate. 2.7–0.8 mm, anthers 1.2 mm. Upper floret lemma 2.8–3.2 × 0.9–13 mm, oblong-lanceolate, acute, palea 25–2.9 × 0.8–1.1 mm; anthers 1 mm.

*Specimen cited:* NBU campus, Mondal et. al. 09 dated 10.04.2019.

*Oryza sativa* L., Sp. Pl.ed.1. 333. 1753; Hook. f., Fl Brit. Ind. 7: 92.1896: Bor, Grass. Ind. 605. 1960; Noltie, Fl. Bhutan 3(2): 517. 2000. **“Dhan”**

Inflorescence 13–17.5 cm, lowest branches single or paired Spikelets 7.52–85 × 3–32. persistent. Sterile lemmas equal, 2–24 × 0.8 mm, triangular, acute, weakly keeled glabrous margins whitish-green.

Fertile lemma 7–8.2 mm, each side 2–22 mm wide, oblong, abruptly acuminate, surface finally reticulately pitted, sparsely hispid on sides above, keel shortly ciliate near apex. Palea 6.7–8 mm, abruptly acuminate each side 12–1.4 mm wide narrowly oblong, keel and sides shortly hispid above anthers 1.8 mm.

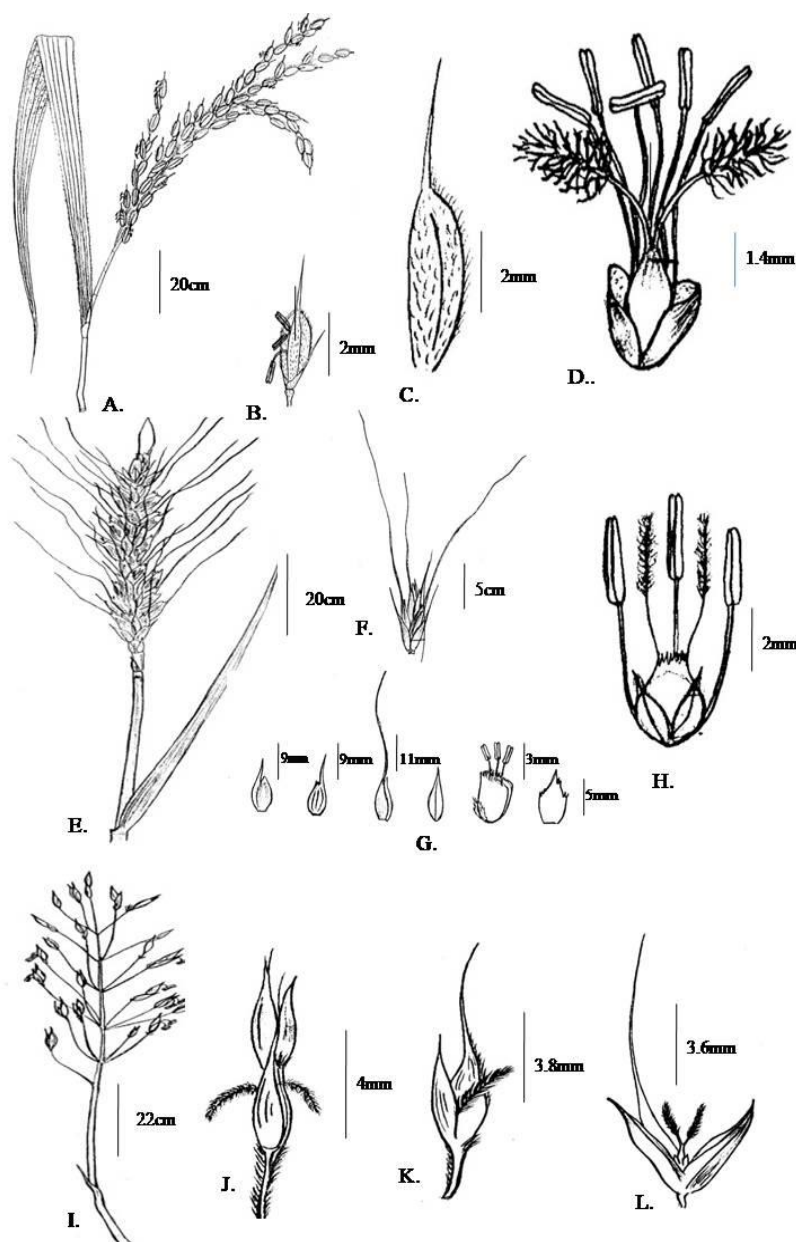
*Specimen cited:* NBU campus, Mondal et. al. 04, dated 24.03.2019

*Paspalum scrobiculatum* L., Mant. Pl. 1: 29. 1767, Hook. f., Fl. Brit. Ind 7 10. 1896. Hour., Blumea 3: 439 1940; Ohwi, Act Phytotax Geobot. II 40.1942, Bor, Grass. Ind. 340.1960; Noltie, Fl. Bhutan 3(2): 713. 2000.

Spikelets 1.9–2.2 mm pedicels 0.3–0.6 mm. Upper glume 15–18 mm, broadly elliptic, concave. blunt or subacute, glabrous, 5 veined, thin herbaceous, margins unruffled Upper floret lemma broadly elliptic, convex blunt, crustaceous, smooth, margins, inrolled, elapsing palea 1.6–18 × 12–15 mm.

crustaceous, back flat, margins inflexed, expended in middle; anthers 0.7 mm.

Specimen cited: Gorumara National Park, Mondal et. al. 014 dated 21.04.2019



**Fig. 2:** A-D. *Oryza sativa*, A. habit, B. spikelet, C. lemma, D. pistil; E-H. *Triticum aestivum*, habit, F. spikelet, G. glumes, H. pistil; I-L. *Chrysopogon asiculatus*, I. habit, J. spikelet, K & L. female flower

*Saccharum spontaneum* Linnaeus, Mant. Pl. 2: 1771; Hook. f., Fl. Brit. Ind. 7: 118. 1896; Obwi, Act Phytotax Geobot. 11 151. 1942; Bor, Grass. Ind. 214. 1960; Noltie, Fl. Bhutan 3(2): 764. 2000. “Kash”

Sessile spikelet 3–3.3 mm: lower glume 3–32 mm narrowly to oblong-lanceolate, finely acuminate or apex sometimes rounded. glabrous, 2-veined, lower part golden to reddish-brown, thickened, upper part silver -hyaline, margins ciliate below apex: upper glume 2.7–3.3 mm. lanceolate, acuminate, glabrous, margins fimbriate: lower lemma 26–3mm,

lanceolate, margin ciliate, upper lemma reduced, filiform, 1.4–26 mm: palae absent or small, 0.09 mm Pedicelled spikelet similar, pedicel 1.7–2.3 mm anthers 12–2.8 mm.

Specimen cited: NBU campus, Mondal et. al 011. dated 14.04.2010.

*Triticum aestivum* L., Sp. Pl. ed. 1. 85. 1753; Bor, Grass. Ind 679, 1960; Noltie, Fl. Bhutan 3(2): 640. 2000. *Triticum vulgare* Vill., Hist. Pl. Dauph. 2:153.1753; Hook. f., Fl. Brit. Ind. 7: 367. 1897.

“Gaam”

Spikelets 12.7 –15 cm excl. awns. Glumes 8.4–9.3 mm, 0.6–2.9 mm. Lemma each half 3–4 mm wide, glabrous or hairy near margins, awn 0.4–62 mm, palea 3.3– 4mm; anthers 2.3–3mm. Rachilla internodes bearing third floret 1.3–2.5 mm.

*Specimen cited:* Jalpaiguri, Mondal et. al 011. dated 14.04.2010.

## Conclusion

Present study explored the unique characteristic peculiarities of 14 species of grasses from the terai and duars region. The spikelets of the recorded species are quite fascinating structures and found no lodicule in 3 species like *Digitaria ciliaris*, *Imperata cylindrica* and *Axonopus compressus*. In all cases the stigma is feathery and anther is versatile. The glumes are hairy in *Paspalum scrobicularum*, *Eragrostis unioides*, *Eleusine indica* and *Imperata cylindrica*. In *Oryza sativa*, the 1<sup>st</sup> and 2<sup>nd</sup> glume became suppressed and awn is very acute and hard whereas it is less acute, long and curved in *Triticum aestivum*.

## References

- Christenhusz, M.J.M.; Byng, J.W. (2016). "The number of known plants species in the world and its annual increase". *Phytotaxa*. Magnolia Press. 261 (3): 201–217. doi:10.11646/phytotaxa.261.3.1.
- Calderon, C. E., & T. R. Soderstrom, 1973. *Morphological and anatomical considerations of the grass subfamily Bamhusoideae*, based on the new genus *Maclurolyra*. Smithsonian Contributions to Botany, 11: iii Pp55.
- Clayton, W. D. & S. A. Renvoize, 1986. *Genera Graminum*. Kew Bull. Add. Ser. XIII. Royal Botanic Gardens, Kew.
- Jain, S. K. 1986. *The Grass genera of India - A synoptic account of uses and phytogeography*. Bull. Bot. Surv. India 28: 229–240.
- Karthikeyan, S., Jain, S. K., Nayar M. P. & M. Sanjappa, 1989. *Florae Indicae enumeratio: Monocotyledonae*. Botanical Survey of India, Calcutta.
- Kiranraj M. S., M. Sivadasan & N. Ravi, 2003. *Grass Diversity of Kerala – Endemism and its phytogeographical significance*. Plant diversity, Human welfare and Conservation. Goa University, Pp. 8–30.
- Mitra, S. & S. K. Mukherjee, 2015. *Diversity of Grass Flora of West Bengal with Special Notes on their utility*. Pointer Publishers Jaipur 302 003 (Raj.) India.
- Moulik, S. 1997. *The Grasses and Bamboos of India*. Vols.1&2. Sceintific Publishers, Jodhpur.
- Noltie, H.J. 1994. *Flora of Bhutan (Including a Record of Plants from Sikkim and Darjeeling)*; Royal Botanic Garden: Edinburgh, UK, 3:1.
- Pal, D. C., Guha Bakshi, D. N. & B. P. Uniyal, 1991. *Composition and a check list of Grasses of West Bengal*. Nat. Bot. Soc. Supp. 2. 45:1–18.
- Pal, D. C. 2010. *Grasses and Bamboo in West Bengal*. West Bengal Pollution Control Board (WBPCB). pp248.
- Paul P., Dhar S, Das D., Chowdhury M. 2020. *Herbarium Techniques: Evolution from Conventional to Digitization*. Orange Book Publication, India. 128 pp.
- Prain, D. 1903. *Bengal Plants Vol-I & II*. Bishen Singh and Mahendra Pal Singh. Dehradun.
- Watson, L. & M. J. Dallwitz, 1992. *The Grass genera of the World*. CAB International, Wallingford, UK.
- The Plant List, <<http://www.plantlist.com>>