Paper ID: 1073
Theme 4. Biodiversity, conservation and genetic improvement of range and forage species
Sub-theme 4.1. Plant genetic resources and crop improvement

Collecting genetic resources of major forage grasses in India: Progress and future strategies

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Keywords: Exploration and collection, Forage grasses, Genetic resources

Introduction

Indian gene centre possesses rich genetic and species diversity in native forage grasses (1256 spp.), as about one third of them, chiefly belonging to the tribes namely Andropogoneae, Paniceae and Eragrostideae, are of forage importance (Handbook of Agriculture, 2009). Forage grasses are important source of livestock feed. Collecting genetic diversity in major native forage species, occurring in both wild (mostly in rangelands) and cultivated state, is of paramount importance in conservation and use. Considerable genetic variability has also been generated in some introduced forages (e.g. *Panicum maximum*, *Brachiaria* spp.) as a result of repeated introductions followed by acclimatization due to cultivation under various climatic conditions of India. Since inception in 1976, ICAR-NBPGR has been nodal organization at country level for survey, exploration, collection, characterization, documentation and conservation of plant genetic resources (PGR) *viz*., landraces of crops, their wild relatives, and other economic plants including forages.

Materials and Methods

We analysed collection status for 15 major forage grasses (excluding cereal fodders) at ICAR-NBPGR (including collections made by the erstwhile Plant Introduction Division of Indian Agricultural Research Institute from 1950s) till March 2015. These species are *Brachiaria* spp. (para grass; signal grass), *Cenchrus ciliaris* (buffel grass; anjan grass), *C. setiger* (syn. C. setigerus; yellow anjan grass), *Chloris gayana* (Rhodes grass), *Chrysopogon fulvus* (dharaf/dhawalu grass), *Dichanthium annulatum* (marvel grass), *Lasiurus scindicus* (syn. L. hirsutus; sewan grass), *Panicum maximum* (Guinea grass), *Pennisetum pedicellatum* (dinanath grass), *P. purpureum* (Napier grass), *Setaria sphacelata* (syn. S.anceps; golden bristle grass), *Sorghum bicolor* nothosubsp. drummondii (syn. S. sudanense; Sudan grass), *Urochloa mosambicensis* (sabai grass) (Handbook of Agriculture, 2009), and two temperate grasses such as *Festuca* spp. (fescue grass) and *Lolium* spp. (ryegrass).

Results and Discussion

The analysis revealed that 1297 accessions were collected in 32 taxa (native-26; introduced, cultivated and naturalized-6) belonging to the genepool of above 15 forage grasses. About 40 per cent accessions (519) remained without species identity; majority belonging to *Panicum* (318), *Sorghum* (139) and *Pennisetum* (21). Grassland Survey Scheme operational by the ICAR during 1950s to 60s made the base for systematic forage germplam collection (which resulted into deposition of 541 herbariums at National Herbarium of Cultivated Plants, ICAR-NBPGR). Majority of above germplasm collections (57%) were made during 1995-2005 (World Bank aided National Agricultural Technology Project on Plant Biodiversity was operational at ICAR-NBPGR during that time) followed by 1980-1990 (24%). Species-wise highest collections include *Dichanthium annulatum* (237), *Cenchrus ciliaris* (94), *Lasiurus scindicus* (84), *Setaria helvola* (syn. *S. pumila*, *S. glauca* auct., *S. pallidefusca*; 66) and *Cenchrus setiger* (56). Collection database indicated that variability in selected characters was collected in some forage grasses such as *Cenchrus setiger* (panicle colour as light brown, dark brown, red, bluish), *Panicum antidotale* (panicle colour as greyish brown, brown, pink, light pink, light green, pinkish green; internodal length) and *Lolium temulentum* (awned and awnless nature of spikelet).

In general, only a limited number of accessions of forage grasses have been collected from south India, eastern and north-eastern region (NER), Upper Gangetic Plains (UGP) and Andaman & Nicobar Islands (A&N), indicating the need for systematic explorations in these main centres of diversity. Collection gaps identified for major forage grasses (including their related species forming a genepool) based on the distribution pattern and diversity richness are mentioned in Table 1. Surprisingly no collection of germplasm of introduced and cultivated grasses *viz*., *Brachiaria mutica*, *B. ruziziensis*, *B. brizantha*, *Sorghumbicolor* nothosubsp. *drummondii* and *Urochloa mosambicensis* was made from the country. Very poor collections are reflected in common native grasses like *Chrysopogon fulvus* (3acc.), *Festuca* spp. (6) and *Lolium* spp. (7); their diversity needs to be augmented from diverse habitats across altitudinal and distributional ranges.

Table 1: Gaps identified for germplasm collection in major forage grasses in India

S.no.	Species	Collected accs.	Remarks & gaps identified
1.	*Brachiaria* spp. (*mutica*, *ruziziensis*,*brizantha*)	-	*B. mutica* needs collection from naturalized populations in warm humid situations of high rainfall areas, water-logging conditions; *B. ruziziensis* and *B.brizantha* needs to be augmented from humid tropics of Western Ghats (WG), North Eastern Hill (NEH) region, and hot-semi-arid areas with red and black soils
2.	*Cenchrus ciliaris*	94	Though rich diversity was collected from Rajasthan (68 acc.), further to be augmented from adjoining arid and semi-arid regions and Tamil Nadu; closely related *C. pennisetiformis* (also close to *C. setiger*) needs collection from similar areas
3.	*C. setiger*	56	Good representative collection from Rajasthan (42) made, but requires collection from areas mentioned for *C. ciliaris*
4.	*Chloris gayana*	5	African species, naturalized in a few pockets in tropical and warm temperate areas; all other eight species occurring in India may form its genepool
5.	*Chrysopogon fulvus*	4	Distributed in diverse habitats, needs collection especially from warmer areas of peninsular India, central Indian Plateau, arid and semiarid regions of north-western India; close relatives *C. serrulatus*, *C. aucheri* and *C. polyphyllus* also deserve collection
6.	*Dichanthium annulatum*	237	Rich diversity augmented from Madhya Pradesh (79), Rajasthan (60), and Maharashtra (51); needs adequate representation from diverse habitats of country; naturally hybridizes with *D. caricosum* and *D. aristatum*, hence they can also form the collection target
7.	*Festuca* spp. (*arundinacea*, *rubra*)	6	Temperate Himalaya needs to be explored; natural interspecific/intergeneric hybridization revealed worthiness to prioritize collecting other Himalayan wild species, especially *F. pratensis*
8.	*Lasiurus scindicus*	84	Well collected from Thar Desert of Rajasthan; now needs focused/trait-specific collection through fine-grid survey
9.	*Lolium* spp. (*temulentum*)	7	All five species (genepool of *L. perenne*) occurring as weeds in temperate hills, needs collection, especially from Western Himalaya (WH)
10.	*Panicum maximum*	15	Well adapted, commonly cultivated African species deserves more collection from central and south India, NEH region; also related wild species *P. coloratum* from Shiwaliks of WH and adjacent *terai* region
11.	*Pennisetum pedicellatum*	13	African species, wild/naturalised in grasslands and strands; requires more collection across the country, especially eastern India, A&N
12.	*P. purpureum*	5	African species, naturalised in few pockets, needs collection from WG, WH, NEH region and A&N
13.	*Setaria sphacelata*	1	Brazilian species, introduced for silvipasture in tropical Himalaya, NEH region, UGP; naturalized population from above areas could form the target; related species *S. helvola*, was collected from Deccan region, but to be collected from rest of India up to 2100m

14.	*Sorghum bicolor* nothosubsp. *drummondii*	-	African hybrid taxa, very close to cultivated sorghum, deserves collection from peninsular India and NER
15.	*Urochloa mosambicensis*	-	East African species, requires collection from Tamil Nadu, Andhra Pradesh, besides related species *U. panicoides* and *U. setigera*

Some challenges involved in germplasm collection of forage grasses are as follows:

- Difficulty in getting sufficient seed sample required for conservation owing to problems of harvesting before flowering/seed set, asynchronous flowering, seed shattering, large number of sterile glumes (blank/empty seeds), *etc*. Also, collecting endemic and threatened species is now a priority; out of 168 species coming under respective genus boundary of these target grasses in India, 13 were mentioned as threatened.
- Minimizing loss of collected material before reaching for conservation. Only 392 accessions (25%) of collected germplasm got conserved in long-term storage in National Genebank at ICAR-NBPGR. Reasons could be due to several factors like seed sample not meeting out genebank standards, problems faced during seed regeneration/multiplication, some forage germplasm maintained as vegetative propagules in National Active Germplasm Sites, *etc*.
- Expertise availability in grass taxonomy is insufficient; as a result, about 40% of germplasm could not be identified up to species level in Collection Database. Identification and illustrative keys are essential for a general PGR worker while collecting. Thorough understanding of species relationships, pollination behaviour, crossability, ploidy status, apomixis, *etc*. will pave way for scientific collection of PGR of forage grasses. As quality components (like crude protein, dry-matter digestibility etc.) continue to remain as key breeding objectives, physio-biochemical characterization of collected germplasm would help in locating the trait-specific germplasm for utilization as well as for searching elite germplasm in probable/similar localities through GIS tools.

Conclusion

Germplasm of 15 major forage grasses consisting of 1297 accessions were collected from different agro-ecological regions of India and collection gaps have been identified. Some issues related to exploration, collection and conservation are also highlighted.

References

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Acknowledgement

Authors acknowledge support and guidance of Director, ICAR-NBPGR for this work.