Tropical Ecology **43**(2): 359-362, 2002 ISSN 0564-3295

Environment and population differentiation in *Desmostachya bipinnata* (Linn.) Stapf in western India

AMITA PANDEYA & S.C. PANDEYA

Department of Botany, Raja Balwant Singh College, Agra 282005, India

Key words: *Desmostachya bipinnata*, morphological differences, water status, western India.

Desmostachya bipinnata (Linn.) Stapf (Family Poaceae, tribe Eragrosteae), a tall, tufted, leafy perennial grass occurs widely in a variety of climo-edaphic conditions in western India. The species is distributed throughout India, Persia, North Africa to Tropical Africa (Bor 1960). In western India the ecoclimate varies from extreme arid desert (Thar desert) to semiarid (oceanic to inland). The soils in this region are desert sand, sometimes gypiferous to fresh to old alluvial. This grass branches from thick root stock, sending out rhizomes in all directions, making it an excellent sand binder (Bhandari 1990; Kaushik 1983). The morphometric description of *Desmostachya bipinnata* given by Bor (1940) does not tally with the characters of this grass collected from the four typified localities in western India. When two different Herbarium sheets of *D. bipinnata*, one from Jodhpur and the other from Agra were sent to Royal Botanic Garden, Kew, Cope (1998, pers. comm.) stated that "both the specimens without doubt are of *Desmostachya bipinnata* (Linn.) Stapf. The species can be very variable in habit". The main aim of the present investigation was to evaluate the population differences in *Desmostachya bipinnata* growing in four selected localities representing different environmental conditions in western India.

The geographical distribution, ecoclimate, and water status of four localities selected for the present study are shown in Table 1. The climate of the study sites ranges from oceanic (Ahmedabad) to extreme arid (Jodhpur). The water status (annual precipitation and soil water storage less potential evapotranspiratioin) of these sites varies widely, from 500 mm at Jodhpur to 2200 mm at Ahmedabad with intermediate values for Nehchani (900 mm) and Agra (1350 mm). From these localities composite soil samples were collected from two depths (0-25 cm and 25-50 cm), brought to Agra, and analysed for physical and chemical characters by the standard methods given by Piper (1944), Jackson (1968), Misra (1968) and Pandeya *et al.*

Table 1. Ecoclimate and water status of four different localities where *D. bipinnata* occurs in western India.

Locality and population code	Lat. N	Long. E	Altitude (m) amsl	Ecoclimate	Water status (mm)
Ahmedabad (DBAHM)	23° 04′	73°38′	55	Oceanic semi-arid	2200
Jodhpur/ Barmer (DBJB)	26°18′	78°01′	224	Extreme arid	500
	25°45′	78°45′	551		
Nehchani near Bharatpur (DBNB)	27°13′	77°29′	227	Arid to semi-arid	900
Agra (DBAG)	27°10′	78°02′	169	Semi-arid	1350

Water status = Annual precipitation (mm) + soil water storage (mm) – potential evapotranspiration (mm).

(1968). The soil physical and chemical properties at the four localities differed (Table 2). Soil texture at these localities varied from sandy loam to clayey loam. The water holding capacity was generally medium. The organic C and total N status of these soils were low. All soils were basic in reaction, possessing high amounts of exchangeable cations (particularly Ca and Na).

Root stocks of *Desmostachya* were brought from the selected field sites and transplanted separately in the Neutral Garden at Agra. Vegetative and reproductive characters of the four populations of *Desmostachya* were monitored both in the field conditions and in the Neutral Garden during the period September 1998 to July 2000. The values given in Table 3 are mean of the field

Table 2. Ranges of physical and chemical characters of the soils of four localities where *D. pinnata* is growing.

Parameters	Ahmedabad	Jodhpur	Nehchani	Agra
Soil texture				
Gravel and sand (%)	68-79	50-59.2	38-55	72-90
Silt (%)	4-7	15-25	23-40	2-10
Clay (%)	12-24	15-30	20-35	2
Water holding capacity (%)	21-51	31-37	26-43	14-51
pH	8.1-9.3	7.6-8.4	7.6-8.4	7.5-9.2
Organic C (%)	0.60-1.40	0.62-1.17	0.30-1.76	0.60-1.10
Total N (%)	0.6-0.13	0.02-0.05	0.02-0.05	0.07-0.1
Exch. Na (ppm)	550-840	30-207	134-286	150-790
Exch. K (ppm)	160-250	1-46	1-319	110-290
Exch. Ca (ppm)	980-1560	1634-6428	3032-6597	310-1620
Avalable-P (ppm)	8-10	1-283	64-255	2-10

Table 3. Vegetative and reproductive characters of *Desmostachya bipinnata* from four localities in western India; values are mean ±SD.

Parameters	Ahmedabad	Jodhpur	Nehchani	Agra
Length of leaf (cm)	132 ± 43	110 ± 10	121 ± l7	116 ± 31
Width of leaf (cm)	0.59 ± 0.08	0.69 ± 0.13	0.97 ± 0.01	0.88 ± 0.01
Length of leaf sheath (cm)	16.2 ± 3.6	16.3 ± 7.7	20.5 ± 2.3	18.6 ± 3.2
Length of terminal leaf sheath (cm)	28	15	30	31
Length of leaf on terminal leaf sheath on culm (cm)	26	16	62	30
Length of culm (cm)	122 ± 15	135 ± 24	148 ± 6	141 ± 23
Length of panicle (cm)	24.2 ± 4.2	48.5 ± 3.6	52.5 ± 4.2	33.8 ± 4.6
Diameter of panicle (cm)	1.7 ± 0.22	5.0 ± 0.65	4.3 ± 0.47	2.5 ± 0.38
Number of spikes per panicle	101 ± 13	135 ± 23	181 ± 13	127 ± 7
Length of rachis (spikes), LR (cm)	0.9 ± 0.14	2.4 ± 0.39	2.1 ± 0.26	1.3 ± 0.23
No. of spiklets/rachis	29 ± 3	45 ± 3	39 ± 3	29 ± 3
Length of spikelet, LS (cm)	0.88 ± 0.12	0.3 ± 0.03	0.4 ± 0.05	0.4 ± 0.01
No. of flowers per spikelet	19 ± 3	7 ± 0	7 ± 2	9 ± 2
LR/LS ratio	0.9 ± 0.1	7.4 ± 0.9	5.5 ± 0.7	3.4 ± 0.7
Date of flowering	20-25 May	23 Jun-10 Jul	2-6 Jun	1-6 May

data and the Neutral Garden data. The vegetative and reproductive characters varied amongst the four populations. Leaf length in *Desmostachya* was minimum during winter, and leaves emerging later show increase in length until October. Flowering was initiated during summer at different intervals (May-July), in the four populations. The flowering initiation dates were: earliest in DBAG, midway in DBAHM and DBNB, and last in DBJB. The relative values of important characters were (Table 3):

1. Length of leaf, DBAHM>DBNB>DBAG >DBJB.
2. Width of leaf, DBNB>DBAG>DBJB >DBAHM.
3. Length of panicle, DBNB>DBJB>DBAG >DBAHM.
4. Diameter of panicle, DBJB>DBAG>DBAG >DBAHM.
5. Length of spike (rachis) (LR), DBJB>DBNB >DBAG>DBAHM.
6. Length of spikelet (LS), DBAHM>DBNB >DBAG>DBJB.
7. Number of spikelets/rachis, DBJB>DBNB >DBAG>DBAHM.
8. Number of flowers/spikelet, DBAHM>DBAG >DBJB=DBNB.
9. Length of terminal leaf on culm was more than panicle length in DBNB.
10. LR/LS ratio, DBAHM>DBJB>DBNB>DBAG.
11. Date of flowering differed by more than 2 months in the four populations.

The ranges of different morphological features of *Desmostachya bipinnata* collected from the four localities were subjected to analysis of covariance with the help of MICROSOFT EXCEL Programme on computer. Covariance is a measure of relationship between two ranges of data (Sokal & Rohlf 1969). This analysis was done to evaluate whether the regressions depicting ranges of various morphological parameters in different localities differed significantly from each other. The covariance analysis showed that all the morphological characters in the four population significantly differed, suggesting these population to be separate entities. The level of significance with respect to difference between morphological parameters at different localities were variable, as shown below:

Highly significant at 1% level: Length of rachis (spike), Number of spikelets per spike, Length of spikelet, LR/LS Ratio.

Significant at 2% level: Length of leaf, Width of leaf, Length of culm, Diameter of panicle, Number of flowers per spikelet.

Significant at 5% level: Length of panicle, Number of spikes per panicle.

The following 6 characters emerged as distinguishing characteristics of the four population of *Desmostachya bipinnata:* (1) Length of spike (2) LR/LS ratio (3) Length of terminal leaf on culm (4) Length of spikelet (5) Number of flowers per spikelet (6) Date of flowering.

The four population can be clearly distinguished on the basis of LR/LS ratio which varies widely from 0.91 (DBAHM) to 7.4 (DBJB). The LR/LS ratio in different population is inversely related with the water status of the localities (DBAHM 2200 mm, DBJB 500 mm). The increase in LR/LS ratio with increasing aridity mainly occurs due to considerable elongation of the rachis relative to the length of spikelet.

In view of the morphological distinctiveness of the four population of *D. bipinnata* in western India, it is proposed to consider them as subspecies. Accordingly,

DBAHM: *Desmostachya bipinnata* sub- sp. *longispiculata* Amita Pandeya spp. nov.

DBJB: *Desmostachya bipinnata* sub- sp. *jodhpurensis* Amita Pandeya spp. nov.

DBNB: *Desmostachya bipinnata* sub- sp. *sheelai* Amita Pandeya spp. nov.

DBAG: *Desmostachya bipinnata* sub- sp. *agraensis* Amita Pandeya spp. nov.

A distinguishing description of these sub- species is given in Appendix I. Marked differences in the climatic and edaphic of the habitats of the 4 sub-species calls for the experimental evaluation of their environmental relations.

Acknowledgements

We are highly grateful to Prof. R.K.S. Rathore, Head, Department of Botany, Raja Balwant Singh College, Agra, for providing laboratory facilities and fruitful discussions from time to time. We owe special gratitude to Dr. Vijay Lakshmi Singh for discussions.

References

Bhandari, M.M. 1990. *Flora of the Indian Desert*. MPS Repros, Pali Road, Jodhpur.

Bor, N.L. 1940. *Common Grasses of United Provinces*. Indian Forest Research Institute, Dehradun.

Bor, N.L. 1960. *The Grasses of Burma, Ceylon, India and Pakistan.* Pergamon Press, Oxford.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Kaushik, J.P. 1983. *Flora of Shivpuri* (*Madhya Pradesh*). Mehra Offset Press, Shivpuri, Agra.

Misra, R. 1968. *Ecology Work Book*. Oxford and IBH, New Delhi.

Pandeya, S.C., G.S. Puri & J.S. Singh. 1968. *Research Methods in Plant Ecology*. Asia Publishing House, New Delhi.

Piper, C.S. 1944. *Soil and Plant Analysis*. University of Adelaide, Adelaide.

Sokal, R.R. & I.J. Rohlf. 1969. *Biometry: The Principles and Practice of Statistics in Biological Research*. W.H. Freeman & Co., San Fransisco.

Appendix 1. Distinguishing characters of four populations of *Desmostachya bipinnata*.

(1) *Desmostachya bipinnata* subsp. *longispiculata* Amita Pandeya ssp. nov.
Leaves 75-230 cm long, 0.7 cm. wide; leaf-sheath 7-21 cm long, terminal leaf-sheath on culm 28 cm with 26 cm leaf on it, shorter than panicle; flowering 20-26 May; culm 89-135 cm long; panicle 17-30 cm long, diameter 1.3-2.0 cm; number of spikes on panicle 87-118; length of spike 0.5-1.0 cm; number of spikelets per spike 20-33 (always odd number); length of spikelet 0.8-1.1 cm; ratio of length of spike to length of spikelet 0.91-1.0; number of flowers per spikelet 15-25 (odd number).
Holotypus 913, R.B.S. College, Agra, Isotypus ibid. Amita Pandeya

(2) *Desmostachya bipinnata* subsp. *jodhpurensis* Amita Pandeya ssp. nov.
Folia 94-123 cm long, 0.7 cm. wide; leaf-sheath 11-21 cm, terminal leaf-sheath on culm 15 cm with leaf 16 cm, much shorter than panicle; flowering 23 June- 10 July; culm 100-164 cm long; panicle 40-53 cm, diameter 4.0 – 6.0 cm, number of spikes per panicle 100-170; length of spikes 2.0-3.0 cm; number of spikelets per spike 39-47; length of spikelet 0.3-0.35 cm, ratio of spike-length to length of spikelet 6.6-10.0; number of flowers per spikelet 7 (odd number).
Holotypus 914, R.B.S. College, Agra, Isotypus ibid. Amita Pandeya

(3) *Desmostachya bipinnata* subsp. *Sheelai** Amita Pandeya ssp. nov.
Leaves 90-180 cm long, 1.0 cm. wide; leaf-sheath 16-26 cm, terminal leaf-sheath on culm 30 cm with leaf on it 62 cm, 20 cm longer than panicle; flowering 2-6 June; culm 140-161 cm; panicle 45-61 cm, diameter 3.9-5.0 cm; number of spikes on panicle 154-213; length of spikes 1.5-2.4 cm; number of spikelets per spike 35-43; length of spikelet 0.3-0.45 cm; ratio of length of spike to length of spikelet 4.4-7.1 number of flowers per spikelet 5-11.
Holotypus 915, R.B.S. College, Agra, Isotypus ibid. Amita Pandeya
*The subspecies named after the late mother of the senior author.

(4) *Desmostachya bipinnata* subsp. nov *agraensi*s Amita Pandeya ssp. nov.
Leaves 59-197 cm long, 0.88 cm. Wide; leaf-sheath 12-23 cm long, terminal leaf-sheath on culm 31 cm with 30 cm leaf on it, shorter than panicle; flowering 1-6 May, culm 92-l73 cm long; panicle 24-40 cm long, diameter 2.0-3.0 cm; number of spikes on panicle 108-137; length of spikes 0.9-1.8 cm; number of spikelets per spike 19-33; length of spikelet 0.3-0.7 cm; ratio of length of spike to length of spikelet 2.5-4.5; number of flowers per spikelet 5-11.
Holotypus 916, R.B.S. College, Agra, Isotypus ibid. Amita Pandeya