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BRIEF COMMUNICATION

Photosynthetic Pigments — a Prerequisite of Grass Productivity*

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Abstract

In twenty grass species the amounts of chlorophyll (Chl) *a* and *b* and β-carotene (Car), specific leaf mass and leaf water content at the pre-flowering stage were determined. The decrease in Chl a/b ratio was usually accompanied by an increase in Chl $(a + b)$ and specific leaf mass (SLW). High SLW and Chl $(a + b)$ of *Chloris gyana* Kunth. and *Brachiaria dictyoneura* L. showed the shade adaptive features of these grasses. The high ratios of Chl a/b and low Chl $(a + b)$ of *Chrysopogon fulvus* Spreng., *Paspalum notatum* Fluegge, *Setaria sphacelata* Schomach. and *Brachiaria mutica* Forssk. indicated their light adaptive features. *Sehima nervosum* Rottl., *Dicanthium annulatum* Forssk., *Panicum antidotale* Retz. and *Bothriochloa intermedia* R. Br. with a medium Chl (a/b) (2.18 – 2.74) ratio, had a high concentration of Chl *a*, Car and a low leaf water content may be very productive in a tropical environment.

The grasslands in India are under excessive pressure of biotic factors, such as fire, grazing and shifting cultivation. Due to these factors many grass species have a low productivity. Grasses of the genera *Panicum*, *Sehima*, *Setaria*, *Cenchrus*, *Chrysopogon*, *Heteropogon*, *Paspalum*, *Bothriochloa* and *Dicanthium* form the major communities of grass covers in India. Most of them are perennial and have a very broad ecological amplitude that depends on the acclimation of various physiological processes. The contents of photosynthetic pigments in different environments might be one of the important parameters for the adaptive potential of plants and therefore we measured them in some grass species native in India.

Twenty grass species (Table 1) were grown for two years in a field of an experimental farm of the Indian Grassland and Fodder Research Institute, Jhansi (U.P.) under optimum nutrient (40 kg N and 30 kg P_2O_5 per ha) supply. The soil of the experimental field was neutral, medium textured, shallow 18 to 23 cm deep murram layer.

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Table 1

Contents of chlorophyll (Chl) and β-carotene (Car) and specific leaf mass (SLW) of different species of grasses. Figures in parentheses indicate SD values.

Grass species	Pigments [g kg^{-1}(d.m.)]					SLW	Leaf water content
	Chl ($a + b$)	Chl a	Chl b	Chl a/b	Car	[g m^{-2}]	[%]
	Species with high Chl a/b ratio						
Chrysopogon fulvus SPRENG.	3.14 (0.53)	2.68 (0.52)	0.46 (0.03)	5.86 (1.03)	1.11 (0.29)	49.76 (1.9)	74.2 (2.72)
Paspalum notatum FLUEGGE	3.39 (0.36)	2.66 (0.10)	0.73 (0.28)	3.66 (1.26)	1.14 (0.09)	40.73 (1.3)	74.2 (2.10)
Setaria sphacelata SCHUMACH.	3.86 (0.43)	2.99 (0.17)	0.87 (0.26)	3.42 (0.99)	1.57 (0.39)	33.46 (2.5)	84.3 (1.81)
Brachiaria mutica FORSSK.	3.49 (0.31)	2.65 (0.01)	0.84 (0.32)	3.16 (1.44)	1.08 (0.17)	44.10 (1.8)	75.9 (1.56)
Cenchrus ciliaris L.	3.70 (0.16)	2.78 (0.14)	0.92 (0.22)	3.01 (0.91)	1.26 (0.18)	45.65 (0.6)	79.7 (0.35)
Average	3.52	2.75	0.76	3.82	1.23	42.74	77.7
	Species with medium Chl a/b ratio						
Dicanthium annulatum FORSSK.	5.94 (0.64)	4.35 (0.57)	1.59 (0.37)	2.74 (0.73)	2.11 (0.32)	41.05 (3.2)	74.7 (1.2)
Bothriochloa pertusa L.	4.39 (0.56)	3.22 (0.50)	1.18 (0.32)	2.74 (1.00)	1.50 (0.26)	38.20 (1.4)	73.3 (0.71)
Panicum polystachyon L.	4.02 (0.20)	2.94 (0.28)	1.08 (0.08)	2.72 (0.49)	1.67 (0.24)	41.64 (0.9)	82.5 (0.95)
Panicum antidotale RETZ.	4.54 (0.17)	3.27 (0.10)	1.27 (0.15)	2.58 (0.46)	1.54 (0.11)	41.05 (1.3)	71.4 (0.65)
Chrysopogon sp. (var. Chandigarh) SPRENG.	3.25 (0.16)	2.32 (0.01)	0.94 (0.17)	2.48 (0.70)	1.07 (0.12)	41.00 (1.7)	70.5 (1.71)
Sehima nervosum ROTTL.	6.35 (0.28)	4.51 (0.22)	1.84 (0.14)	2.46 (0.25)	1.80 (0.19)	41.02 (1.4)	70.1 (1.26)
Cyanodon dactylon L.	3.19 (0.06)	2.26 (0.08)	0.93 (0.02)	2.44 (0.15)	1.25 (0.03)	46.65 (0.70)	64.4 (2.05)
Panicum maximum JACQ.	3.74 (0.12)	2.63 (0.10)	1.10 (0.54)	2.39 (0.09)	1.68 (1.8)	42.17 (1.8)	72.2 (2.0)
Bothriochloa intermedia R. Br.	4.54 (0.16)	3.18 (0.22)	1.35 (0.06)	2.35 (0.29)	1.39 (0.08)	47.74 (1.1)	72.2 (0.31)
Heteropogon contortus L.	2.62 (0.23)	1.80 (0.13)	0.82 (0.11)	2.19 (0.35)	0.97 (0.16)	46.71 (1.0)	64.7 (0.95)
Average	4.26	3.05	1.20	2.51	1.50	42.72	71.6

Table 1 (*continued*)

Grass species	Pigments [g kg^{-1}(d.m.)] Chl ($a + b$)	Chl a	Chl b	Chl a/b	Car	SLW [g m^{-2}]	Leaf water content [%]
	Species with low Chl a/b ratio						
Cenchrus setigerus VAHL.	3.69 (0.54)	2.45 (0.21)	1.25 (0.35)	1.96 (0.63)	1.25 (0.17)	45.60 (4.5)	77.8 (1.50)
Chloris gyana KUNTH.	3.21 (0.47)	2.12 (0.18)	1.08 (0.31)	1.96 (0.63)	0.81 (0.02)	51.58 (3.0)	74.7 (1.08)
Brachiaria dictyoneura L.	3.33 (0.37)	2.16 (0.26)	1.17 (0.11)	1.85 (0.03)	1.75 (0.07)	54.03 (3.4)	78.8 (1.40)
Brachiaria decumbens STAPF.	4.94 (0.51)	3.14 (0.27)	1.81 (0.29)	1.73 (0.26)	1.59 (0.07)	40.9 (0.6)	72.0 (0.11)
Brachiaria brizantha HOCHST. ex A. RICH.	2.94 (0.55)	1.74 (0.28)	1.20 (0.28)	1.45 (0.17)	1.29 (0.09)	39.3 (1.5)	74.9 (0.8)
Average	3.62	2.32	1.30	1.79	1.35	46.28	75.6
LSD (0.05 P)	0.63	0.45	0.36	1.16	0.30	3.52	2.54

Soil contains 0.06 per cent nitrogen and 5.3 kg available phosphorus. After the establishment and regeneration of these grasses during the Kharif season (July – October) fresh leaves were taken for the determination of chlorophyll (Chl) and carotene (Car) contents and of specific leaf mass (SLW). Chl and Car contents were estimated by extracting the leaf tissues (1 g) in 80 % acetone and measuring of absorbance at 660, 640, 510 and 480 nm on the *Spectronic 20* of *Baush and Lomb*. The amounts were calculated using the equations of Duxbury and Yentsch (1956). The leaf area of 20 random leaves of each species was measured with an automatic leaf area meter (model *LI-3000*, *Licor*, U.S.A.). The leaves were dried in an oven at 80 °C to constant mass. SLW per leaf area unit was measured at the pre-flowering stage of grasses.

All the studied grass species were categorised into three groups on the basis of Chl a/b ratio (Table 1). This ratio decreased usually due to a relative increase in Chl b content. A correlation between high Chl a/b ratio and high efficiency of photosynthesis found by Black and Mayne (1970) was valid also for most of the species studied in our work (cf. the data on the total dry matter – Rai 1985, Rai and Patil 1985).

Shade plants have a higher relative content of Chl b than Chl a (Egle 1960, Goodchild *et al.* 1972). In this respect *Chloris gyana* Kunth. and *Bracharia dictyoneura* L. with a high relative Chl b content showed shade adaptive features and had a higher SLW (>5) than the other species. *Chrysopogon fulvus* Spreng., *Paspalum notatum* Fluegge, *Setaria sphacelata* Schomach., and *Brachiaria mutica* Forssk. with a high

Chl a/b ratio and low Chl b content showed light adaptive features (Table 1). For the grass species medium in Chl a/b (2.19 – 2.74) ratio, a high Car and low leaf water content very typical; this species may be highly productive in a tropical environment.

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