

Flowering Phenology, Seed yield and its Quality in Palisade Grass [*Brachiaria brizantha* (A. Rich.) Stapf]

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ABSTRACT Studies on flowering phenology and component of spikelet yield in *Brachiaria brizantha* under rain grown condition revealed that initial head emergence (IHE) started in the first week of August after the start of monsoon initiated growth during June end. Head density peaked in the third week of August when seed shedding was on the way. Seed yield was 710 and 571 kg/ha/year in 1998 and 1999, respectively. Dual dormancy mechanism was evident as scarification of the rigid husk by H₂SO₄ enhanced germination indicating coat-imposed dormancy due to the rigid husk. However, the effectiveness of dormancy breaking treatments (viz. H₂SO₄ + GA₃, H₂SO₄ + KNO₃) was reduced after 12 months of storage suggesting another mechanism of dormancy also in operation (physiological dormancy), which was overcome during after-ripening in storage. Low seed setting (28-32 %) and germination (18-25 %) and immediate shattering of seeds suggest that prevailing climatic conditions of the site were not favorable for quality seed production.

Keywords: *Brachiaria brizantha*, seed yield, germination, flowering phenology, dormancy.

Brachiaria brizantha (A. Rich) Stapf, commonly known as palisade grass or Ceylon sheep grass is a native of tropical Africa but now introduced into most tropical countries as an important perennial fodder grass [1]. It was introduced into India from Australia for trials during late forties [2]. It is fairly drought tolerant and also tolerate shade under coconut in Sri Lanka but prone to flooding [3]. It has been successfully used for soil erosion control in India [1]. Seed yield and its purity in grasses is site specific as biological seed production potentials of each geographic region is determined by prevailing climatic conditions [4,5]. Similarly site characteristics also influence dormancy and germination of the grasses [6]. As a result seed yield in tropical grasses varies from place to place and year to year [7,8]. Therefore, an experiment was conducted during monsoon (July to September) of 1998 and 1999 with the aim (i) to study the flowering phenology and seed yield potentials of this grass under rain fed condition and (ii) to examine the seed quality (as reflected by per cent seed set and

germination), dormancy status and effect of various dormancy breaking treatments on germination as this grass play an important role in forage production systems in the tropics and sub-tropics.

MATERIALS AND METHODS

The experimental site and environment: The experimental site was the Central Research Farm of the Indian Grassland and Fodder Research Institute, Jhansi, India (25 31' N latitude and 78 32' E longitude at 237 m above the mean sea level). Soil characteristics and weather parameters of the site has been described elsewhere [9,10,11]. Five permanent quadrats (1x1 m²) were marked out at the onset of monsoon during July start in an established pasture. Fertilizer N and P was applied @ 20 kg/ha in the first week of July during both the years. Pasture was rejuvenated during July 1998 by gap filling using rooted slips and weeding so as to obtain an uniform strand. One additional quadrat

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was used for tagging the tillers after initial head emergence (IHE) in the first week of August (when 5-7 heads / m² were visible) for recording observation on duration of anthesis, seed setting and seed shedding. Seed yield was estimated in each quadrat by recording peak inflorescence density multiplied by mean seed yield per head [8]. The quadrats were harvested during third week of August, when peak density was observed and seed shedding was on the way. Tillers were separated into flowering and non flowering and morphological characteristics of 20 flowering tillers (selected randomly from each replication) were measured for tiller height (base to the tip of inflorescence), tiller diameter (at the middle of lowest internode), panicle length, seed yield per head, leaf/stem ratio etc.

Seed was also collected from rest of the field, dried in shade and stored in polyethylene bags at room temperature for subsequent germination studies. Room temperature during seed storage varied from 15 °C during winter (December-January) to 38 °C during summer (May - June) and relative humidity of the room ranged from 30-35 % during September -October, when seeds were stored in polyethylene bags. Per cent seed setting was determined by dehusking the 'seed' (100 × 5). While dehusking the 'seeds' for determining per cent seed set 'seeds' were categorised into filled (caryopsis + husk) and empty (no caryopsis) and weight of 1000 caryopsis and their husk and weight of empty 'seed' were recorded so as to know the weight difference between a filled and an empty 'seed'. The germination test was conducted on top of paper (TP) at 20/30 °C (16/8 hrs) with 8 hrs. light (3 × 40 W fluorescent tubes) during upper temperature per day as per standard ISTA procedure used for tropical *Brachiaria species* [12]. 100 seeds with four replication were used and 21 days were taken as standard period for germination. Freshly collected as well as stored seeds showed dormancy, therefore, following treatment were imposed to break the dormancy of seeds after 3, and 12 months of storage. The treatments were : control i.e. no treatment; sulfuric acid treatment, seeds treated with conc., sulfuric acid for two minutes and washed before the start of germination; H₂SO₄ + pre chilling, sulfuric acid treated seeds were moistened and kept at 5 - 7°C for seven days before sowing; sulfuric acid treated seeds moistened with 500 ppm solution of gibberellic acid; and sulfuric acid treated seeds moistened with 500 ppm solution of KNO₃ at the start of germination and subsequently with distilled water.

RESULTS AND DISCUSSION

Flowering phenology and seed yielding components

Growth of the pasture started after the commencement of monsoon during June end / July start and sward height was about 85 - 90 cm by the end of July. Inflorescence exertion started in the first week of August (when an inflorescence was fully exerted above the flag leaf) and tillers with head measured 101 to 107.6 cm (Table 1). The development of aerial tillers (axillary) located in the leaf bases of a main tiller was evident at inflorescence exertion stage. Head density peaked during third week of August, when shedding of seeds started. Immediately after the emergence of panicle above the flag leaf, anthesis started acropetally, marked by exertion of the anthers and stigma and dehiscence of anther, releasing pollen, in the forenoon and continued for about 2-3 days on a single head. The inflorescence is a panicle with usually 4-6 spike like racemes attached to main axis alternately. The racemes, about 5-6 cm long, have double rows of spikelets and caryopsis is tightly enclosed in a floret. The spikelets turn green to brown after anthesis at maturity. Seed setting completed within 5-6 days of anthesis and shedding started after about 11 days of anthesis and completed within 3 days of shedding commencement. Axillary tillers (aerial) located within leaf bases of a main tiller also produce heads in acropital succession (in majority of cases) after the seeds were shed by the earlier heads. The first formed heads (apical) were larger and produced heavier seeds. A typical large flowering tiller produced up to 4 - 5 axillary panicles by the end of August. Shedding of seeds completed by first week of September. A panicle has a short life span of about 15 days and seed collection after 12-15 days of IHE would provide quality seeds harvested from apical panicles, when shedding has already started.

The sward accumulated 327 and 362 g/m² dry matter (c. 90 % of annual dry matter (DM yield)) after about 50 - 60 days of monsoon initiated growth during 1998 and 1999 respectively (Table 1). However, DM yield was less as compared to 7 - 8 t/ha in Fiji and 10 -17 t/ha in Sri Lanka [1]. Tiller density as well as DM yield was higher during 1999, possibly due to the rejuvenation of the sward in the previous year. However, seed yield was less during 1999 possibly due to higher tiller density and lower tiller fertility (Table 1). Seed yield was found to be 710 and 571 kg/ha during 1998 and 1999 respectively, which is higher as compared to other

tropical grasses [4,5]. Seed setting (28 - 34 %) with about 20-25 % pure germinating seeds (PGS) was low. Harvesting index of 21.7 % and 15.7 % for total seed yield in 1998 and 1999 respectively was higher and comparable to temperate grasses [13].

B. brizantha required shortest period (c. 40 - 45 days) for vegetative growth before entering into reproductive phase as it was the earliest flowering perennial grass in the region, which produced seeds during August (rainy month) as compared to other indigenous perennial grasses yielding seeds during October - November [11,14,15]. Therefore, it appears that prevailing climatic condition in respect of temperature, humidity, rainfall etc. were not favorable for quality seed production as regions with good potential for grass seed production are characterized by moderate climate, less humidity, maximum and minimum temperature not exceeding 30 and 9 °C respectively and relatively calm and still weather with little or no precipitation during anthesis and seed ripening [5,16].

The dispersal unit (seed) is a spikelet, each with two floret of which only upper one is fertile. The caryopsis is held tightly within the hard, stiff lemma and palea. The surrounding glumes are hairy and make the seeds chaffy. *En masse*, seeds are light and bulky and do not flow freely because their individual units tend to become entangled and hairy surface interfere with the separate and individual movement of seeds. Therefore, there are two main approaches for determining physical purity in seeds of grasses. For 'seeds' that flow freely and will separate easily in an air stream (e.g. *Panicum* species) a caryopsis must be present before the seed unit can be classed as pure seed - the so called International method. However, in case of chaffy seeds, a less stringent definition is applied, classifying a seed as 'pure seed' provided they look as though they could contain a caryopsis - the so called Irish method. In such cases the alternative is to determine manually whether or not a caryopsis is present [17]. A filled seed is about two times heavier than an empty one and caryopsis accounted for 52 - 57 % of total 'seed' weight, while husk contributed 43 - 48 %. Coefficient of variation (100 x 10) was less than three in filled or empty seeds and less than six in random. The spikelets are broadly elliptic - oblong, apiculate, hairy and measured (L x W) about 4-5x2-3 mm. The elliptic - oblong and apiculate caryopsis measured (L x W) about 3x2 mm with an apical end (2mm) drawn out (Fig. 1).

Seed set and germination

Seed setting in spikelets determine the purity of 'seeds' and depend upon prevailing environmental condition during anthesis and grain formation and genotype of the plant [8,9]. Seed setting ranged from 27 - 32 % and seeds exhibited coat imposed dormancy as removal of caryopsis from the enclosing husk facilitated germination in some (c. 10 %) caryopses, compared to no germination in the intact seed. Scarification of the rigid husk by H₂SO₄ and also subsequent treatment with GA₃ and KNO₃ enhanced percent germination of seed significantly (Table 2). However, the effectiveness of these treatments was reduced and it was not significantly different with each other (except control i.e. no treatment) with increasing storage period up to 12 months, suggesting that there is an another kind of dormancy also in operation in the seed. Many workers [18,19,20] have also outlined a similar dual dormancy mechanism in a range of perennial grasses. Intact seeds also required a longer period for germination exceeding 12 days (without treatment) but scarified and treated seeds started germination after 6-7 days.

Overcoming of coat dormancy by acid treatment is common in grasses [6]. Gibberellic acid, potassium nitrate and pre chilling have been found very effective in breaking dormancy of grass seed and their role in dormancy reduction has been discussed in detail by Simpson [6].

Germination was less compared to other grasses listed in Indian Minimum Seed Certification Standard [21] though seed standards and seed testing protocols in respect of this species as well as many other tropical range grasses are yet to be formulated and it is one of the most neglected area of research from seed technological point of view [22,23]. Germination was also less compared to other perennial native grasses of the region [10,11,15,18] indicating that environment of the site is not ideal for quality seed production or the improved genotype of the plant need to be identified for the purpose.

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Table 1. Sward characteristics and components of spikelet yield in *B. brizantha* at 50 days of growth.

Sward characteristics/ Components of spikelet yield	Kharif 1998	Kharif 1999
Tiller density/m ²	254.4 (11.0) ¹	268.0 (20.5)
Tiller fertility %	55.0 (11.4)	47.0 (12.0)
Main tiller height (cm)	107.6 (8.7)	101.5 (7.5)
Diameter of main tiller (mm)	3.1 (16.5)	2.7 (14.5)
Leaf: stem ratio	0.42 (17.3)	0.34 (21.0)
Dry matter yield (g/m ²)	327.0* ² (9.7)	362.0* (12.6)
Head density (m ²)	161.8* (17.2)	142.0* (18.2)
Panicle length (cm)	15.3 (19.8)	13.5 (14.3)
Raceme numbers/panicle	5.4 (4.8)	5.0 (3.2)
Seed yield (mg/head)	441.5* (20)	402.0* (22.7)
Seed yield (g/m ²)	71.0* (22.6)	57.1* (25.3)
Seed yield (kg/ha)	710	571
Seed set (%)	32.4 (10.6)	27.3 (5.6)
Ist head emergence	Ist week of August	Ist week of August
Date of peak head density and commencement of shedding	3rd week of August	3rd week of August
Weight of caryopses (1) (g)	0.948(57)*	0.904(52)
Weight of filled seeds (g)	1.659	1.748

¹ Figures in parentheses are % coefficient of variation.

² Means marked* differ significantly (P=0.05)

* Figure in parentheses shows per cent weight of total seed weight

Table 2. Effect of dormancy breaking treatments on per cent germination of seeds stored for 3 and 12 months.

Storage period (months)	Control	H ₂ SO ₄	Treatments			C.D (P=0.05)
			H ₂ SO ₄ + Prechill	H ₂ SO ₄ + GA ₃	H ₂ SO ₄ + KNQ ₂	
3	0	8.3(17.6)*	11.0(19.3)	15.3(22.9)	13.0(21.3)	3.6
12	9.0 (17.4)	21.5 (27.5)	19.3 (25.9)	23.0 (28.6)	21.5 (27.6)	4.7

* Figures in parentheses indicate arc sine transformed value.

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