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# Seed Production and Germination in Buffel Grass (*Cenchrus ciliaris* Linn.) Genotype CAZRI 75 under Arid Conditions

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**Abstract**: Genotype CAZRI 75 of buffel grass (*Cenchrus ciliaris* Linn.) sown in 2003 was evaluated for seed yield, its components and germination during 2003 to 2005. The average seed yield was 149.5, 119.9 and 152.0 kg ha$^{-1}$ during 2003, 2004 and 2005, respectively. In first year the seed yield of second harvest was more than the first harvest, while in second year more than 90% of the total seed yield was from the first harvest. Seed germination ranged from 9.8% to 29.4%. During 2005 seed of the first two of the three harvests showed more than 29% germination meeting the requirement of Indian Minimum Seed Certification Standards. In the fourth year the crop could not survive, may be due to single or combined effect of the genotype and the environmental conditions.

**Key words**: *Cenchrus ciliaris*, seed production, seed yield components, germination.

Pasture development programmes in arid and semi-arid areas of the country need quality seed, which is not available in sufficient quantity. Buffel grass (*Cenchrus ciliaris* Linn.), a perennial pasture species, has a wide adaptability in varied edaphic habitats. This is an important grass species of *Cenchrus-Dichanthium-Lasiurus* type grass cover of India (Dabadghao and Shankarnarayan, 1973). The prolonged period of inflorescence production and heavy seed loss due to early shedding of mature seeds make it difficult to harvest quality seed in this pasture species. Therefore, identifying time of seed harvest is critical for optimizing seed yields of buffel grass. This paper describes an experiment in which the seed yield, its components and germination of buffel grass genotype CAZRI 75 were studied during 2003, 2004 and 2005 under arid climate.

## Materials and Methods

The experiment was conducted at the Central Research Farm of the Central Arid Zone Research Institute, Jodhpur. The climate of this area is arid characterized by exceptionally hot, dry summers, sub-humid monsoon and cold, dry winters. The soil is loamy sand with pH 8.1 and low nutrient levels with 0.23% organic carbon, 0.03% nitrogen and 10-15 kg ha$^{-1}$ available phosphorus.

During 2003 (Year 1), the year of establishment, rainfall was 419.7 mm with 26 rainy days, of which more than half (17) were in the month of July. Years 2004 (Year 2) and 2005 (Year 3) were drought years with total rainfall of 220.4 mm and 283.0 mm, respectively. Normally, the summer rains come in the first week of July, but in 2004 it was late and more than 50% of the rainfall was received in the month of August with 7 rainy days. Similarly during 2005, though more rains were in July, but subsequent rains were less causing agricultural drought. The temperature goes up to 48°C in summers and the average temperature was maximum in May during 2003 (41.0°C), in April during 2004 (40.9°C) and in June during 2005 (41.5°C). Maximum RH was more than 80% in July to September in 2003 and August 2004. In 2005 the maximum RH was 78% in the month of August.

Seeds of *C. ciliaris* genotype CAZRI 75 were sown through direct seeding on 14 July 2003. The experiment was rainfed and no fertilizer/manure was applied. Five permanent quadrates (2.25 m x 2.25 m) having nine plants each, with spacing of 75 cm within and between rows were marked to record the data from monsoonal (summer) growth. Inflorescence initiation took place during first year on 10$^{th}$ August, in second year on 8$^{th}$ August and in third year on 8$^{th}$ July. The data on plant height, flag leaf length (excluding leaf sheath) and flag leaf width were recorded at the start of seed harvesting. The mature spikes were harvested manually before the seed fall during August 29 to October 19 in 2003, August 24 to October 1 in 2004 and July 22 to September 9 in 2005 to record seed yield and spike density. By August 2006 the plants even after 117 mm rains did not regenerate. Each year ten spikes were taken randomly during the period of first harvest to record spike length, seeds spike$^{-1}$ and

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*Table 1. Sward characteristics and components of seed yield in C. ciliaris*

| Traits | 2003 | | 2004 | | 2005 | | t-values | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | CV (%) | Mean | CV (%) | Mean | CV (%) | 2003 vs 04 | 2003 vs 05 | 2004 vs 05 |
| Plant height (cm) | 94.60 | 7.7 | 99.10 | 3.6 | 63.60 | 6.7 | 1.257 | 8.194** | 14.372** |
| Fertile tillers (no. $m^{-2}$) | 42.30 | 19.8 | 26.10 | 17.0 | 38.30 | 27.0 | 3.830** | 0.677 | 2.426* |
| Unfertile tillers (no. $m^{-2}$) | 24.10 | 16.0 | 116.80 | 17.2 | 43.90 | 27.4 | 10.150** | 3.502* | 6.968** |
| Flag leaf length (cm) | 28.80 | 12.6 | 25.90 | 4.5 | 22.30 | 13.1 | 1.684 | 3.112* | 2.564* |
| Flag leaf width (mm) | 9.80 | 8.1 | 9.40 | 6.0 | 8.80 | 6.1 | 0.873 | 2.288 | 1.712 |
| Basal cover (%) | 1.22 | 19.3 | 2.04 | 8.9 | 3.86 | 21.7 | 6.124** | 6.783** | 4.756** |
| Dry matter (kg $ha^{-1}$) | 2107.70 | 20.3 | 2057.50 | 13.2 | 1883.10 | 26.8 | 0.222 | 0.760 | 0.682 |
| Spike density (no. $m^{-2}$) | 57.40 | 13.5 | 33.00 | 13.6 | 58.30 | 34.3 | 6.104** | 0.090 | 2.757* |
| Spike length (cm) | 12.00 | 3.9 | 12.40 | 4.5 | 10.60 | 7.2 | 1.113 | 3.568** | 4.231** |
| Seeds $spike^{-1}$ | 145.00 | 6.3 | 143.10 | 12.6 | 108.60 | 6.5 | 0.219 | 7.101** | 3.982** |
| Seed weight $spike^{-1}$ (g) | 0.34 | 14.1 | 0.36 | 12.6 | 0.24 | 6.6 | 0.815 | 4.365** | 5.664** |
| 1000-seed weight (g) | 2.33 | 15.1 | 2.53 | 6.4 | 2.21 | 2.6 | 1.190 | 0.765 | 4.269** |
| Seed yield (kg $ha^{-1}$) | 149.50 | 10.7 | 119.90 | 14.5 | 152.00 | 33.9 | 2.796* | 0.104 | 1.319 |

*P<0.05, **P<0.01

seed weight $spike^{-1}$. 1000-seed weight was recorded from the seeds of the ten spikes. Data on fertile (spike bearing) and vegetative (non-spike bearing) tillers $m^{-2}$, dry matter yield and basal cover were recorded after seed harvesting. 'Seeds' here refer to fascicles, each consisting of clusters of spikelets (usually 1-3) surrounded by an involucre comprising two rows of wavy bristles. An individual spikelet consists of two papery glumes and two florets, each with soft papery lemma and palea.

The harvested seeds were dried at room temperature and stored under ambient conditions in cloth bags. The seed moisture at the time of storage was <10%. Germination tests with 100 seeds from each quadrate (after about 6-month of seed harvest) using quartz sand were conducted in the seed germinator at 20-30°C (20°C for 16-hr and 30°C for 8-hr) in dark and lasted for 28 days. Coefficient of variation, test of significance and simple correlation coefficients were calculated as described by Panse and Sukhatme (1978).

## Results and Discussion

Seed yield $spike^{-1}$ was 0.34 g, 0.36 g and 0.24 g with seed yields of 149.5 kg $ha^{-1}$, 119.9 kg $ha^{-1}$ and 152.0 kg $ha^{-1}$ in 2003, 2004 and 2005, respectively (Table 1). Though highest seed yield was recorded during 2005, but this was statistically at par with the seed yields of 2003 and 2004. The yield of 2003 was 24.7% significantly more than the yield of 2004. The stand of second and third years had the advantage of establishment, but due to less rains the yields were low. Coefficient of variation was minimum in the first year and it increased to 33.9% in the third year showing that the quadrates yields changed with time. Minimum tillers were in Year 1 (66.4) and it was almost double in Year 2. But in the first year fertile tillers were more (63.7%) than Year 2 (18.3%). Again there was decrease in tiller number, of which about half (46.6%) were fertile. There was no significant difference for fertile tillers $m^{-2}$ for 2003 and 2005, whereas during 2004 fertile tillers were significantly less than of 2003 and 2005. Flag leaf length was maximum in Year 1 (28.8 cm) followed by 25.9 cm in Year 2. Flag leaf length in 2005 was significantly less than that in 2003 and of 2004. Coefficient of variation indicated that there was not much difference from quadrate to quadrate for flag leaf length and its width. Flag leaf width was maximum 9.8 mm in Year 1 and minimum 8.8 mm in Year 3. There was no significant change for the flag leaf width over different years. Basal cover was minimum 1.22% in Year 1 and it increased more than three times in Year 3. Dry matter yield, an important component

*Table 2. Seed yield and germination with different seed harvests in C. ciliaris*

| 2003 | | | 2004 | | | 2005 | | |
|---|---|---|---|---|---|---|---|---|
| Harvest period | Yield (kg $ha^{-1}$) | Germination (%) | Harvest period | Yield (kg $ha^{-1}$) | Germination (%) | Harvest period | Yield (kg $ha^{-1}$) | Germination (%) |
| 1. (29-8 to 15-9) | 45.2 | 22.2 | 24-8 to 15-9 | 116.6 | 27.4 | 22-7 to 31-7 | 27.0 | 29.2 |
| 2. (16-9 to 30-9) | 83.3 | 27.8 | 16-9 to 1-10 | 3.4 | 9.8 | 1-8 to 15-8 | 26.3 | 29.4 |
| 3. (1-10 to 19-10) | 21.0 | 11.4 | - | - | - | 16-8 to 9-9 | 98.7 | 20.6 |

*Table 3. Correlation coefficients of seed yield with its components during different years in C. ciliaris*

| Traits | 2003 | 2004 | 2005 |
|---|---|---|---|
| Plant height | 0.055 | 0.545 | 0.942* |
| Fertile tillers | -0.188 | 0.866 | 0.944* |
| Unfertile tillers | 0.601 | -0.025 | 0.106 |
| Flag leaf length | 0.256 | -0.773 | 0.128 |
| Flag leaf width | -0.258 | -0.307 | -0.077 |
| Basal cover | 0.378 | 0.732 | 0.026 |
| Dry matter | 0.783 | -0.330 | 0.887* |
| Spike density | 0.938* | 0.900* | 0.972** |
| Spike length | 0.834 | -0.727 | 0.363 |
| Seeds spike$^{-1}$ | 0.258 | -0.970* | 0.545 |
| Seed weight spike$^{-1}$ | 0.621 | -0.879* | 0.784 |
| 1000-seed weight | 0.537 | 0.242 | 0.519 |
| Seed germination | | | |
| I- Harvest | -0.925* | 0.376 | -0.281 |
| II- Harvest | 0.685 | 0.886* | -0.259 |
| III- Harvest | 0.274 | - | 0.274 |

*P<0.05, **P<0.01

of fodder, was more than 2 t ha$^{-1}$ year$^{-1}$ for the first two years and it decreased to 1.88 t ha$^{-1}$ in the third year, but the differences for dry matter yields were non-significant for the years. Spike density m$^{-2}$ an important seed yield component was minimum in Year 2 (33.0) and was significantly lower than the number in Year 1 and Year 3. In the first and third year the spike density ranged from 55-60. Spike length, seed spike$^{-1}$ and seed weight spike$^{-1}$ were minimum in 2005 and these were significantly lower than their respective values of 2003 and 2004. There was no significant difference in the values for these traits for 2003 and 2004. However, the maximum values were 12.4 cm for spike length, 145.0 for seeds spike$^{-1}$ and 0.36 g for seed weight spike$^{-1}$. 1000-seed weight, was maximum (2.53 g) in 2004, which was significantly higher than that of 2005. Rai *et al.* (1979) reported similar seed yield from cv. IGFRI-S-3108 in two years study at IGFRI, Jhansi. Gobius *et al.* (2001) reported 122 kg ha$^{-1}$ pure seed yield from an inflorescence density of 168 m$^{-2}$ in *Brachiara decumbens* cv. Basilisk.

Seed harvesting started in the last week of August in 2003 and 2004, but its duration was 52 days in Year 1 and 39 days in Year 2. In the third year the seed harvesting started about one month earlier, i.e. July 2005 but its duration was almost same as in the first year. This was due to early start of rains and staggered flowering as in other tropical grasses. Mostly the seed collection period ended by September, except in 2003 where about 14% seed was harvested in the month of October, may be due to moisture availability to the plants as rains were more, 419.7 mm in this particular year. In the first year the harvesting period extended up to third week of October may be due to the age of the plants. Rajora and Singh (2005) reported high seed yields in winter-regenerated flush of *C. ciliaris* during the establishment year. Though seed yield was minimum in 2004, but the seed collection per day was maximum and 97% seed was collected in 23 days due to the availability of soil moisture for a short period leading to early seed maturity, as more than 60% rains were in August 2004 followed by dry spell. Year 2005 was not a good rainfall year, but its distribution was normal during growth period of the grass, as 210 mm was received during July and August out of 236 mm seasonal rainfall. Good distribution of rains enhanced inflorescence production resulting in 64.9% seeds collected from 16$^{th}$ August to 9$^{th}$ September (63$^{rd}$ day of inflorescence emergence) with 20.6% germination.

The seed germination ranged from 20% to 30% when the seeds were collected during July to September in all the three years, except in Year 2 where seeds collected in the second fortnight of September showed 9.8% germination (Table 2) due to severe moisture stress resulting in low yield of poor quality seeds. Overall low seed germination, may be due to the phytochemicals present in the appendages, can be enhanced by removing the inhibitors through washing in the running water. Venter and Rethman (1992) reported that the germination of freshly harvested untreated seeds of *C. ciliaris* varied between 0 and 33%. The minimum seed germination limit in this pasture species is 30% as per the Indian Minimum Seed Certification Standards (Tunwar and Singh, 1988).

Correlation coefficients of seed yield with its components are presented in Table 3. There was positive relationship of plant height with seed yield in all three years and its magnitude changed to significant in Year 3. Similarly, basal cover, spike density and 1000-seed weight had positive association with seed yield, but it was significant with spike density for all the years. Only flag leaf width had a negative association with seed yield during all the years, but these associations were non significant. For other traits, trend was not same from year to year. Seeds spike$^{-1}$ and seed weight spike$^{-1}$ had significant negative association with seed yield only in Year 2. For all the three years spike density showed more than 80% contribution for seed yield. Rajora and Singh (2005) also reported significant association of spike

number plant$^{-1}$ with seed yield in *C. ciliaris* using different accessions. Dry matter showed significant and positive association with seed yield only in Year 3 showing that the environment was most favorable for converting source to sink. Variation in seed germination due to seed yield was less than 10% for seeds harvested during Year 3 and for the last harvest of Year 1. Though the association of seed germination with seed yield was positive and significant in the second harvest of Year 2, but the seed quality was too low. This association showed that more the seed per quadrate better was the germination in Year 2, the most severe drought year. The significant negative association of seed germination with seed yield in Year 1 showed that the quadrates that had high seed yield had poor germination.

Data recorded in August 2006 showed that there was no plant that could survive after three years of its establishment. This may be due to poor adaptability of this genotype after three years in the desert soils of Rajasthan. On the other hand genotype CAZRI 358 of *C. ciliaris* growing in the vicinity of CAZRI 75 is showing 100% survival even after five years of its establishment. There is non-significant difference for dry matter production between CAZRI 358 and CAZRI 75, and seed yield is more than three times in CAZRI 358 than CAZRI 75 for different years of growth (Rajora *et al*., 2006). Seed yield potential in tropical grasses is site-specific as biological seed yield potential of each geographic region is determined by prevailing climatic conditions. Consequently, germination and dormancy characteristics are also site specific (Simpson, 1990). It can be concluded that in arid areas even under less favourable climatic conditions good seed yield can be harvested from genotype CAZRI 75 up to three years of crop age. During drought year collection of seeds should be done within one month of inflorescence emergence and in other years upto two months.

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