

Influence of Meteorological Factors on Forage and Seed Productivity of *Cenchrus ciliaris*

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Abstract High temperatures and windspeeds prevailing in the arid region at Jodhpur had negative correlation whereas, rainfall, humidity and rainy days had positive correlations on forage and seed yield of *Cenchrus ciliaris*. Seed yield of *C. ciliaris* increased from 67 to 153 kg ha⁻¹ with a gradual increase in quantum of seasonal rainfall from 150 to 400 mm. Rainfall at flowering/seed setting stages reduced the seed yield. Only in good rainfall years, application of N and P to the grass had a significant effect on forage, but such a response was not observed on seed yield due to rain and high winds at seed setting/maturity stages. The forage and seed yield relationships of *C. ciliaris* showed that there was a gradual increase in seed yield from 59 to 248 kg ha⁻¹ with increase in the forage yield from 909 to 1565 kg ha⁻¹.

The yield index (T/Tp) computed using RANGETECH model showed that in general with the increase in yield index value from 0.40 to 0.85, the seed production of *C. ciliaris* increased from 0 to 172 kg ha⁻¹. Rainfall explained 1% seed and 36% forage yield, whereas the yield index was useful for prediction of variations upto 24% seed and 76% forage yield.

Key words *C. Ciliaris*, Meteorological factors, Seed production, Arid regions

The Indian arid region which experiences low and variable rainfall, supports arable farming only once in three years, but pasture development in these areas is successful in many of the years. Overgrazing, frequent drought and wind erosion lead to degradation of pasture lands. Therefore, seed production from different grass species is necessary for the rehabilitation of degraded pasture lands through reseeding of perennial grasses suiting to the ecological region.

Henzell *et al.* 1975 reported that *C. ciliaris* needs moisture for at least 5 days for establishment of the seed, but 30 days for adequate growth and a minimum of 30 mm of rainfall to respond to N fertilization. *C. ciliaris* also requires optimum temperature of minimum 5-16°C (Russell & Webb 1976) and maximum 30°C (Ludlow & Wilson 1970) for optimum growth. Not much research effort has gone into the problems of seed production in grasses. Thus in this paper, the seed production of *C. ciliaris* at different levels of N and P in relation to rainfall distribution, weather parameters and yield index was studied.

Materials and Methods

The study was conducted at CAZRI, Jodhpur (26° 18'; 73° 01'; height above MSL 224 m) under rainfed conditions to find the effect of fertilizer application and rainfall distribution on seed yield of perennial grass *Cenchrus ciliaris* (CV 358). The area receives an average annual rainfall of 360 mm with a coefficient of variation of 60%. The grass was established at a spacing of 75 cm between rows and 25 cm between plants within the row in July 1983. The treatments consisted of four levels of N (0, 20, 40 and 60 KgN ha⁻¹) and three levels of P (0, 15 and 30 kg P₂ O₅ ha⁻¹) and in all 12 treatment combinations.

Experiment was laid out in a Factorial Randomised Block Design with 3 replications. The plot size was 7.5 X 10 m. Experiment continued at the same site for ten successive years (1983 to 1992). The full dose of P and half dose of N were placed deep in soil to the sides of established grass rows during rainy season every year. The remaining amount of N was top dressed at late tillering stage. Nitrogen was applied in the form of urea and phosphorus in the form of single superphosphate.

Table 1 Correlation coefficients (*r*) obtained between the weather parameters and forage/seed yield

Weather parameter	Forage yield					Seed yield	
	July	August	September	October	Annual	September	October
Maxi. temp.	-.56	-.60	-.55	-.56	-.71*	.01	-.16
Min. temp.	-.57	-.59	-.30	-.57	-.44	-.08	-.20
Relative humidity	.36	.73*	.71*	.16	.76*	.04	.41
Wind speed	-.52	-.60	-.58	-.42	-.65*	-.26	.22
Sunshine hrs.	-.67*	.05	-.41	-.02	-.65*	.06	.12
Rainfall	.52	.52	.30	.10	.59	-.12	-.36
Rainy days	.66*	.76*	.60	.02	.77*	-.19	-.43

* Significant at 5% level

The soil on which the present investigation was carried out was sandy loam in texture having effective depth of 80 to 100 cm and moisture storage capacity of 120 to 140 mm. The soil was poor in organic matter (0.4%), medium in available P (15-20 kg ha⁻¹) and high in available K (200 kg ha⁻¹). The field capacity, wilting point and bulk density of the soil were 8.8%, 3.0% and 1.5 g cm⁻³, respectively.

The forage yield index (ratio of transpiration, T to potential transpiration, T_p) was calculated using RANGETECH model (Ross Wight & Neff 1983, Ross Wight 1987). The model is used for real-time simulation of daily soil water content and soil plant evaporation and to forecast forage production in terms of a ratio of actual to potential transpiration (yield index). The model is driven by the daily maximum temperature, precipitation and solar radiation. The model also uses soil characteristics like available water capacity, infiltration rate, runoff and plant variables like potential leaf area and relative growth curve of the pasture grass under study. Annual forage/seed yield was calculated by the relationship; yield = Potential site yield x T/T_p (Ross Wight *et al.* 1984).

Results and Discussion

Influence of weather on seed yield of *C. ciliaris*

Rainfall: Seasonal rainfall at Jodhpur varied from 64 mm in 1987 to 775 mm in 1990. The rainfall in July and August accounted for 50% variation in forage yield and the rainfall distribution shown by the number of rainy days had a positive effect on forage yield (Table 1).

The influence of rainfall on seed production of *C. ciliaris* at different N and P fertilization levels is shown in Fig. 1. Seed yield varied from 0 kg ha⁻¹ in 1987 at all N and P levels to 351 kg ha⁻¹ in 1986 at N₆₀+P₃₀ level. The seed yield generally increased from 67 to 153 kg ha⁻¹ with the increase in quantum of rainfall from 150 mm to 400 mm (Fig. 1). Studies on the influence of rainfall distribution on the seed production showed that the rainfall at flowering/seed setting stages of the grass occurred during 1983, 1985, 1988, 1989 and 1990 resulted in lower seed yield (Table 2) compared to the yields obtained during years without rainfall at these stages of the grass. Though the total rainfall was very high in 1990 (775 mm), 57 mm of rainfall occurred at flowering/seed setting stage resulted in lower seed yield (Table 2).

The regression analysis and trends (Table 1 & Fig. 1) in seed productivity in relation to rainfall at different growth stages showed that on an average

Table 2. Mean forage and seed yields (kg ha⁻¹) of *Cenchrus ciliaris*

Year	Seed yield	Forage yield
1983	153	1914
1984	195	2022
1985	67	940
1986	248	1565
1987	0	105
1988	126	2292
1989	59	909
1990	49	2325
1991	88	2069
1992	57	1643

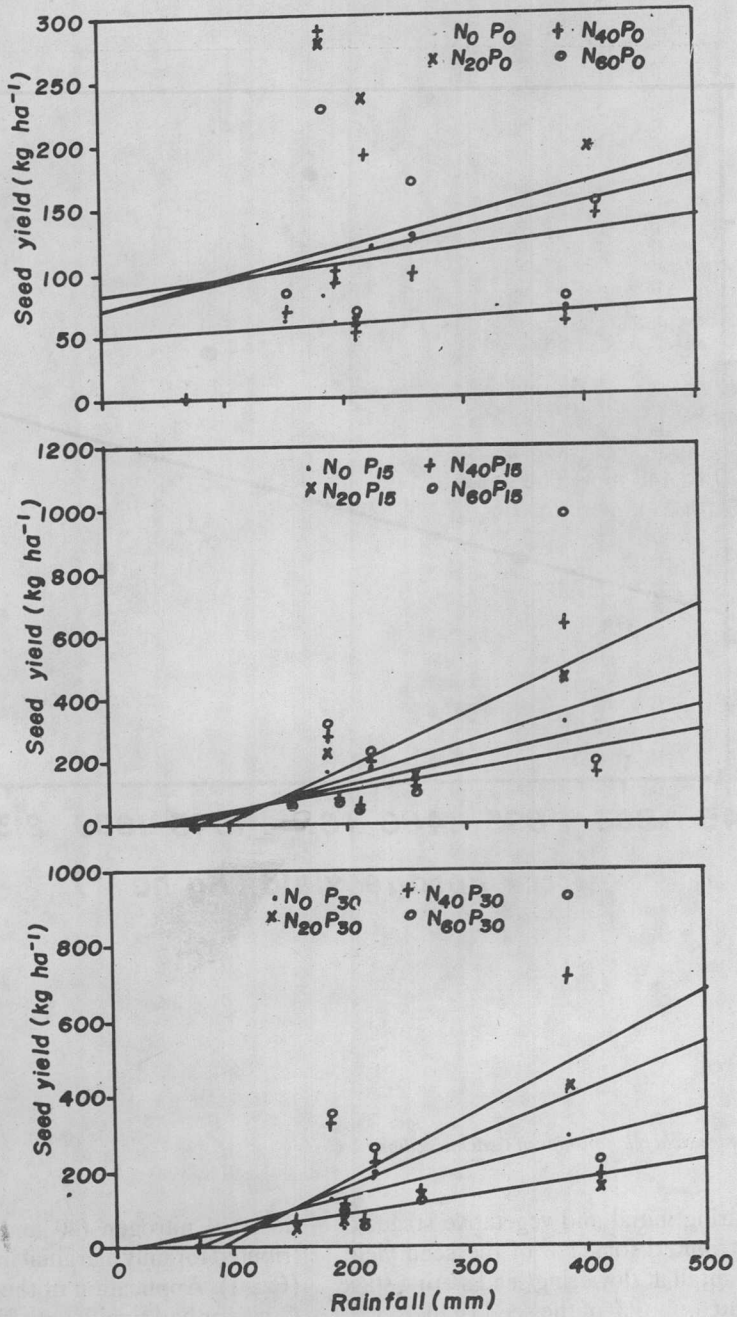


Fig 1 Influence of rainfall on seed production of *Cenchrus ciliaris*

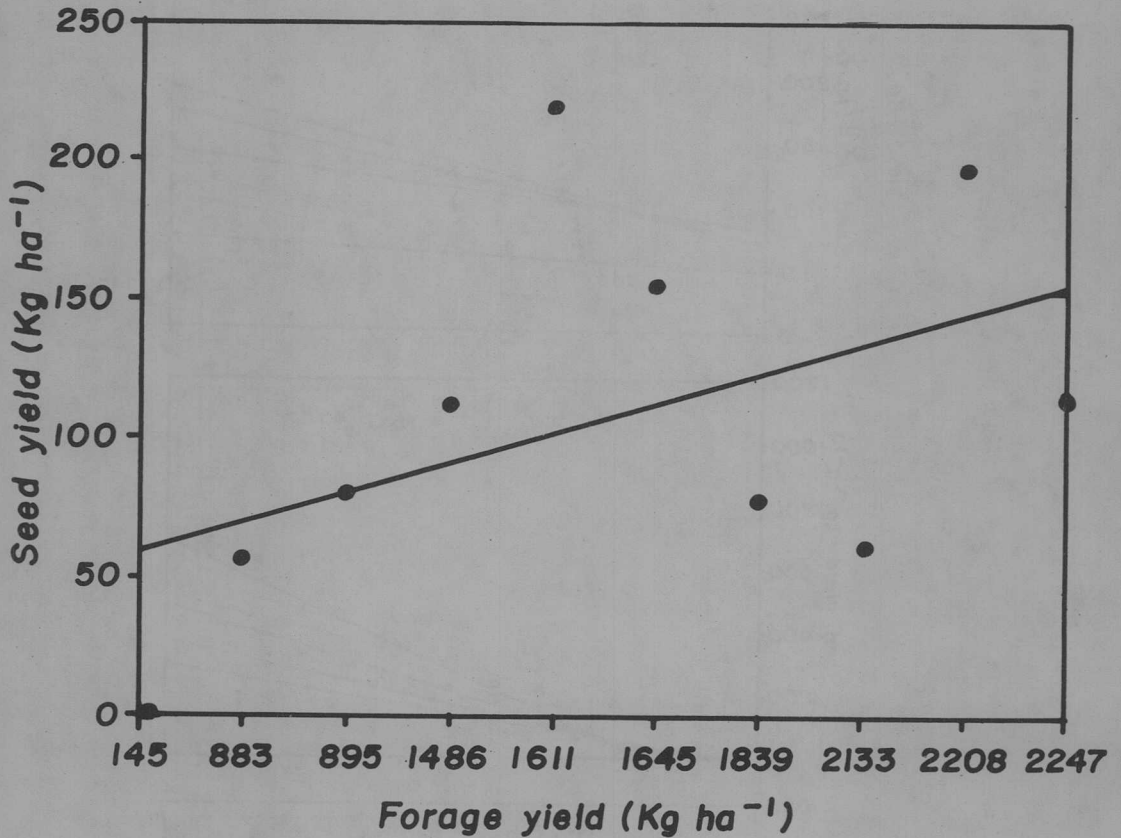


Fig 2 Seed and forage yield relationships of *Cenchrus ciliaris*

the rainfall during initial and vegetative stages of the grass contributed for 27% of the seed yield, whereas the rainfall at flowering/seed setting stage could contribute only 8% of the seed yield.

Application of N at the rate of 20 kg ha⁻¹ to *C. ciliaris* resulted in 83% increase in forage yield and 108% in seed yield over control (N₀P₀). But higher

doses of nitrogen (40 and 60 kg ha⁻¹) had contributed for only marginal increase in the seed yield (Fig. 1). Application of the mixture of N and P to *C. ciliaris* had significant effect on forage yield only in good rainfall situations, but such trend was not observed on the seed yield. In 1990, the forage yield was upto 3378 kg ha⁻¹ at N₆₀P₃₀ level (217% over

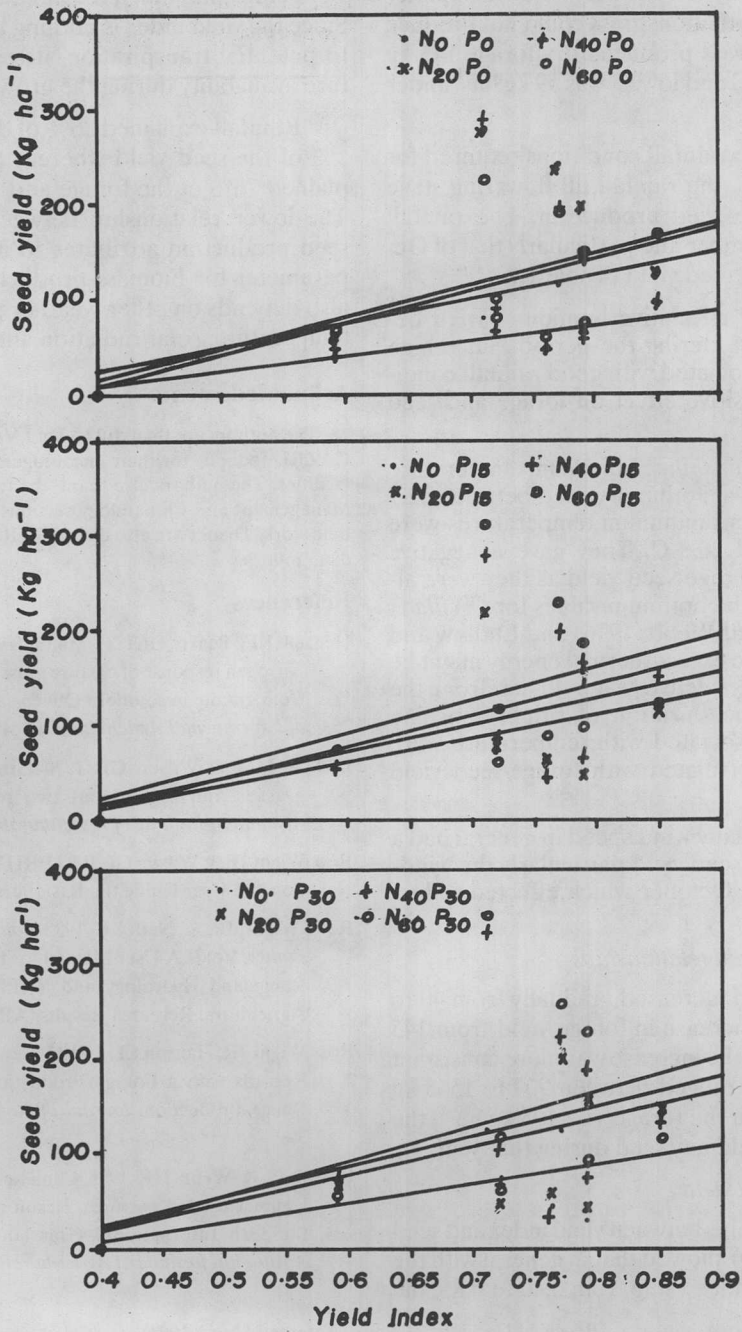


Fig 3 Relationships between yield index and seed yield of *Cenchrus ciliaris*

control), whereas the seed yield at same level of fertility treatment was 56 kg ha⁻¹ (115% over control). In 1987, the rainfall was only 64 mm and under such low rainfall situation, grass could not produce seed. However, grass produced dry forage 145 kg ha⁻¹ at N₂₀P₁₅ level and lowest was 59 kg ha⁻¹ under N₀P₀ (Control).

But unlike the rainfall conditions required for forage production, the rainfall till flowering stage only favoured the seed production. The rainfall occurred in September and particularly that of October effected the seed yield (Table 1).

Relative Humidity : Relative humidity varied between 30 and 91% during the period. Since high humidities are associated with good rainfall conditions, it had a positive effect on forage and seed yield (Table 1).

Air temperatures/Sunshine : Maximum temperature during the season at Jodhpur varied between 32.7 and 38.7°C whereas minimum temperatures were between 18.0 and 26.8°C. They gave a negative correlation with forage/seed yield as they were always higher than the optimum values for *C. ciliaris* given by Russel and Webb (1976) and Ludlow and Wilson (1970). The excess thermal energy might be contributing to ineffective water losses from the pasture grass. The duration of bright sunshine hours which is associated with temperature were also negatively correlated with forage/seed yield (Table 1).

Wind speed : The daily wind speed in general had a negative effect on seed yield particularly the winds in September and October which effected reduction in seed yield.

Seed and forage yield relationships

The seed yield increased gradually from 40 to 150 kg ha⁻¹ with increase in forage yield from 145 to 2208 kg ha⁻¹ but the increase was more consistent when forage yield ranged between 909 to 1565 kg ha⁻¹. In 1987, when the forage was 105 kg ha⁻¹, the grass could not yield any seed during that year.

Yield index vs Seed yield

The relationships between yield index and seed production (Fig. 3) showed that in general with the increase in yield index value from 0.40 to 0.85, the

seed production of *C. ciliaris* increased from 0 to 172 kg ha⁻¹. The grass could not yield seed when the yield index had fallen to 0.40 during the year 1987. Since the yield index is nothing but a ratio of actual to potential transpiration, it represents the moisture availability during the growing period.

Rainfall explained 36% of the forage yield and 1% of the seed yield whereas the yield index explained 76% of the forage and 24% of seed yield. The lower relationship between yield index and seed production attributes to moisture being key parameter for biomass production but seed yield also depends on other weather parameters like air temperature, solar radiation and wind conditions.

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