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SPREAD OF CLONCURRY BUFFEL GRASS (CENCHRUS PENNISETIFORMIS) ON A RIVER LEVEE IN NORTH-WESTERN QUEENSLAND

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SUMMARY

Spread of *Cenchrus pennisetiformis* (Cloncurry buffel grass, previously *C. ciliaris*) from initial strip planting was studied. After 9 years, colonization of the area between the strips had reached the stage where the original plantings were no longer obvious.

Several factors emerged as being of importance to the spread of *C. pennisetiformis* in this semi-arid environment. Trees and logs provided more favourable microhabitats than open areas. Of two soil textural types present, the spread was greater on loam than on loamy sand. Wind was shown to be important in seed dispersal. Lack of spread in the early years after sowing is attributed to the need to accumulate reserves of viable seed in the soil.

I. INTRODUCTION

Buffel grass was first introduced into the Cloncurry district in 1926 and has since spread down the frontages of the Cloncurry River and its tributaries. These deep, light-textured, high-fertility soils are well suited to buffel grass (Humphreys 1967).

While accelerated distribution of this useful perennial grass on suitable soils appears desirable, the cost of planting buffel grass on large pastoral properties in this semi-arid region is high, relative to the value of the land. A suggested method of increasing its presence was seeding limited areas in strips in anticipation of natural spread.

With the planting of *Cenchrus* spp. (buffel and Birdwood grasses) and *Aerva javanica* (kapok bush) on denuded areas of the Ord River catchment in Western Australia, new plants were initially confined to the cultivated strips. In time, the intervening spaces were colonized, first by pioneer annuals and later by the introduced perennials (Fitzgerald 1968). After 8 years, with some additional interstrip cultivation but no additional seeding, the interstrip areas had been well colonized.

The present paper reports the results of an experiment carried out on 'Granada' Station, north of Cloncurry in north-western Queensland. Its aim was to investigate the rate of spread by *Cenchrus pennisetiformis* into a degraded native grass community from planted strips. There was no further disturbance by cultivation and cattle had free access to the area during the dry season.

II. MATERIALS AND METHODS

The experimental area was a levee on the west bank of the Dugald River. Chemical analysis of the 0 to 15 cm layer showed high levels of available phosphorus (> 120 p.p.m. P) and available potassium (0.7 m.e. % K), and a pH of 6.9. Mechanical analysis revealed a variation in soil texture within the area. The first type examined (loamy sand) contained 6% clay, 6% silt, 48% fine sand and 40% coarse sand. The second type (loam) contained 12% clay, 8% silt, 60% fine sand, 20% coarse sand.

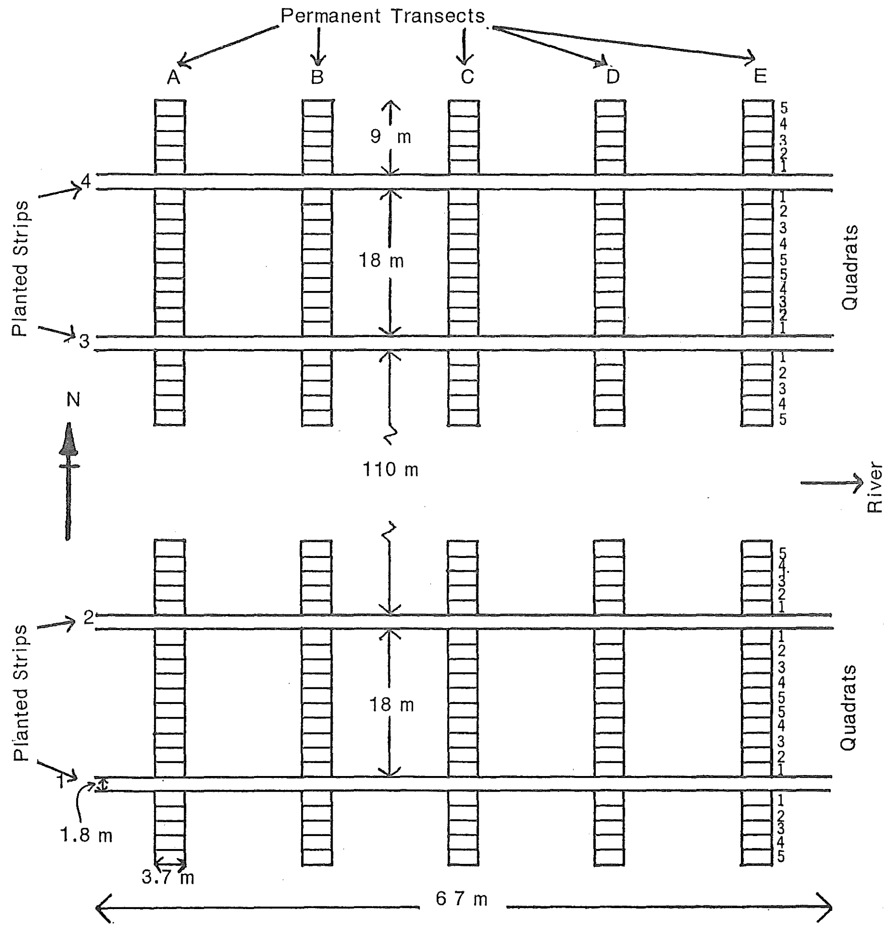

Figure 1. Diagram showing layout of planted strips, permanent transects and sampling quadrats.

The native vegetation was a frontage woodland of *Bauhinia cunninghamii* and *Eucalyptus terminalis.* Buffel grass was absent and prominent native grasses were *Chrysopogon fallax, Aristida pruinosa* and *A. browniana.* Trees and logs were not disturbed before planting or during the trial, and no fires or floods occurred.

The climate is semi-arid tropical. Rainfall is strongly seasonal. Three-quarters of this falls in four summer months (December to March), and is associated with high temperatures, low humidities and high evaporation rates (Bureau of Meteorology 1956). Table 1 shows actual monthly rainfall and August to July totals for Cloncurry, 58 km to the south.

Four strips, each 1·8 m wide and 67·0 m long, were laid out for planting in an east-west direction to be at right angles to both the direction of the prevailing southerly wind in autumn and the river (Figures 1 and 2). The strips were arranged in pairs with a distance of 18 m separating the members of each pair and 110 m between the two pairs. The first pair (strips 1 and 2) was positioned on the area of loamy sand and the second pair (strips 3 and 4) on the area of loam.

The four strips were planted with Cloncurry buffel seed at 9 kg/ha on 5 February 1958. A home-made planter mounted on a chisel plough was used for cultivation and seeding in one operation.

Good establishment occurred on all four strips in the planting year. During the period of the experiment, the area was ungrazed during the wet season but grazed by cattle over the dry season following seed set.

Figure 2. Photograph taken in the eighth year (1966) showing two planted strips and colonization by buffel grass of the interstrip area. The trees in the background are on the river bank.

TABLE 1

RAINFALLS (mm) FOR CLONCURRY OVER THE EXPERIMENTAL PERIOD AND LONG TERM MEANS

Year	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
1957–58	0	0	38	40	76	89	55	24	45	16	33	2	418
1958–59	0	1	7	73	4	104	3	130	0	128	0	0	450
1959–60	2	9	3	2	31	88	75	19	24	34	0	0	287
1960–61	4	10	1	53	207	89	36	6	9	0	0	1	415
1961–62	0	0	81	50	22	113	115	75	6	7	14	3	483
1962–63	0	0	17	10	58	112	44	43	103	9	0	0	396
1963–64	0	0	4	5	6	57	264	43	68	2	3	5	458
1964–65	0	3	31	9	50	17	4	104	0	5	49	0	273
1965–66	0	0	7	3	53	137	15	20	0	1	8	0	244
1966–67	45	2	4	22	55	24	163	82	0	0	0	0	397
1967–68	0	0	0	6	68	26	119	57	13	101	0	14	404
Mean monthly rainfall for 81 years	4	7	14	31	68	109	116	62	19	15	13	8	466

Source: Bureau of Meteorology, Brisbane.

TABLE 3

BUFFEL GRASS DENSITY* IN RELATION TO DISTANCE FROM THE PLANTED STRIPS

Quadrat No.†	Planted Strips 1 and 2 (loamy sand)					Planted Strips 3 and 4 (loam)					L.S.D.	
	1	2	3	4	5	1	2	3	4	5	5%	1%
1965 ..	0·72 (4)	0·56 (3)	0·52 (2)	0·42 (2)	0·43 (2)	0·84 (6)	0·79 (5)	0·77 (5)	0·86 (6)	0·91 (7)	N.S.	
1966 ..	0·86 (6)	0·64 (3)	0·60 (3)	0·44 (2)	0·45 (2)	0·98 (9)	0·86 (6)	0·84 (6)	0·96 (8)	1·03 (10)	N.S.	
1967 ..	1·44 (27)	1·32 (20)	1·09 (11)	0·98 (9)	0·84 (6)	1·67 (46)	1·53 (33)	1·57 (36)	1·55 (34)	1·51 (32)	0·21	0·28
1968 ..	1·20 (15)	1·17 (14)	1·11 (12)	1·07 (11)	0·92 (7)	1·20 (15)	1·20 (15)	1·23 (16)	1·23 (16)	1·33 (21)	0·19	0·25

* Plant numbers per 6·66m² quadrat are transformed as Log (1 + x). Equivalent means of plants per quadrat are shown in parentheses.
† Quadrat No. 1 is adjacent to the planted strip.

Plant density on each side of the planted strips was recorded annually during the winter or early spring, except in 1962, 1963, and 1965. An estimate of plant density is available for 1963 and 1965. Buffel plants were counted growing along five permanent band transects spaced equidistantly at right angles to the strips. Each transect consisted of five contiguous quadrats 3·7 m x 1·8 m (6·66 m^2) on each side of each strip (Figure 1). When seedlings were present, only those that had seeded were counted.

TABLE 2

BUFFEL GRASS DENSITY ESTIMATES FOR INTERSTRIPS 1/2 AND 3/4 (PER 100 x 6·66m^2 QUADRATS)

Year	Interstrip 1/2 (loamy sand)	Interstrip 3/4 (loam)	Totals
1959	8	57	65
1960	4	43	47
1961	9	9	18
1962	No change evi	dent from previ	ous year's count
1963*	127	162	289
1964	426	582	1 008
1965*	356	1 140	1 496
1966	496	1 800	2 296
1967	2 346	5 143	7 489
1968	1 745	2 809	4 554

* Calculated by subtracting the seedling population from total population in 1964 and 1966 respectively.

III. RESULTS

For the first 4 years (1959-1962), plant populations in the interstrip areas were low (Table 2). From then on, they increased considerably, particularly in 1963, 1964 and 1967. A reduction occurred in 1968 (the tenth year).

In the first 3 years, most of the buffel plants recorded were in the quadrats adjacent to the planted strips. Subsequently, the distance from the planted strips had no significant effect on plant density except with strips 1 and 2 in 1967 and 1968 (Table 3).

Plant populations arising from planted strips 1 and 2 were significantly lower than those from planted strips 3 and 4 for the years 1965, 1966 and 1967 (Tables 2 and 4). The greater populations on the northern side of the planted strips were also significant compared with those on the southern side for the years 1965, 1967 and 1968 (Table 5).

TABLE 4

BUFFEL GRASS DENSITY* IN RELATION TO SOILS

Year	Planted Strips 1 and 2 (on loamy sand)	Planted Strips 3 and 4 (on loam)	L.S.D.	
			5%	1%
1965	0·53 (2)	0·83 (6)	0·24	0·35
1966	0·60 (3)	0·93 (8)	0·26	0·38
1967	1·13 (13)	1·57 (36)	0·24	0·36
1968	1·09 (11)	1·24 (16)	N.S.	

* Plant numbers per 6·66m^2 quadrat are transformed as Log $(1+x)$. Equivalent means of plants per quadrat are shown in parentheses.

N.S. difference not significant.

TABLE 5

BUFFEL GRASS DENSITY* IN RELATION TO DIRECTION FROM PLANTED STRIPS

Year	North	South	L.S.D.	
			5%	1%
1965	0·74 (5)	0·62 (3)	0·11	0·14
1966	0·82 (6)	0·71 (4)	N.S.	
1967	1·45 (27)	1·25 (17)	0·09	0·12
1968	1·26 (17)	1·07 (11)	0·09	0·11

* Plant numbers per 6·66m² quadrat are transformed as Log. $(1+x)$ Equivalent means of plants per quadrat are shown in parentheses.

N.S. difference not significant.

In the three-way interaction of direction of spread with planted strip pairs and proximity to the river, significant differences occurred but were not consistent (Table 6). In strips 3 and 4, the apparent increase in population with proximity to the river was not significant.

A greater population of buffel grass plants established in those quadrats influenced by the presence of trees and logs (Table 7). This effect prevailed throughout the duration of the trial (Figure 3).

Figure 3. Photograph taken after completion of experimental period showing superior growth of buffel grass under trees (foreground and background) compared with the open areas (mid distance).

TABLE 6

BUFFEL GRASS DENSITY* RELATIVE TO SOIL, DIRECTION FROM PLANTED STRIPS AND PROXIMITY TO RIVER

Site	Planted Strips 1 and 2 (on loamy sand)										L.S.D.‡	
Direction	North					South					5%	1%
Transect†	A	B	C	D	E	A	B	C	D	E		
1965 ..	0·64 (3)	0·59 (3)	0·68 (4)	0·65 (4)	0·58 (3)	0·41 (2)	0·36 (1)	0·62 (3)	0·21 (1)	0·55 (3)	0·34	0·45
1966 ..	0·74 (5)	0·61 (3)	0·76 (5)	0·67 (4)	0·68 (4)	0·46 (2)	0·41 (2)	0·70 (4)	0·28 (1)	0·65 (3)	0·38	0·50
1967 ..	1·54 (34)	1·11 (12)	1·10 (12)	1·27 (18)	1·43 (26)	0·60 (3)	0·69 (4)	1·29 (18)	1·09 (11)	1·22 (16)	0·30	0·39
1968 ..	1·61 (40)	1·23 (16)	1·08 (11)	1·36 (22)	1·16 (13)	0·58 (3)	0·73 (4)	1·29 (19)	0·87 (6)	1·01 (9)	0·27	0·36
Site	Planted Strips 3 and 4 (on loam)											
Direction	North					South						
Transect†	A	B	C	D	E	A	B	C	D	E		
1965 ..	0·83 (6)	0·65 (3)	0·81 (6)	0·85 (6)	1·14 (13)	0·43 (2)	0·34 (1)	0·84 (6)	1·20 (15)	1·23 (16)	0·34	0·45
1966 ..	0·86 (6)	0·68 (4)	0·86 (6)	0·92 (7)	1·42 (25)	0·49 (2)	0·35 (1)	0·93 (8)	1·38 (23)	1·45 (27)	0·38	0·50
1967 ..	1·37 (22)	1·38 (23)	1·69 (49)	1·76 (57)	1·87 (72)	1·27 (17)	1·01 (9)	1·59 (38)	1·85 (70)	1·88 (76)	0·30	0·39
1968 ..	1·23 (16)	0·76 (5)	1·13 (13)	1·37 (23)	1·67 (46)	1·09 (11)	0·87 (6)	1·24 (16)	1·42 (25)	1·60 (39)	0·27	0·36

* Plant numbers per 6·66m² are transformed as Log (1 + x). Equivalent means of plants per quadrat are shown in parentheses.

† Transect E is closest to the river.

‡ For testing between north and south means only.

IV. DISCUSSION

In this experiment, the most obvious factors influencing spread (apart from rainfall) were the presence or absence of trees and logs on the trial site, the direction of the prevailing wind, and variation in soil texture.

Greater plant numbers near logs would have resulted from mechanical effects such as trapping of seed, soil, litter and also moisture. In the case of trees, apart from a shading effect and accumulation of litter, improved soil nutrient status could be expected, as shown by Ebersohn and Lucas (1965) for several tree species including *Eucalyptus terminalis* in south-western Queensland.

TABLE 7

BUFFEL GRASS DENSITY IN RELATION TO TREES AND/OR LOGS

—	Mean No. of Plants per Quadrat*	
	Influenced by trees and/or logs	Not influenced by trees and/or logs
1964	12	4
1966	38	9
1967	61	32
1968	50	17

* Each 6·66m².

The greater spread of plants recorded on the northern, compared with the southern side of planted strips, is attributed to the fact that in autumn and winter the prevailing wind in this region is from the south (Year Book Australia 1972). Since buffel seed ripens and falls between April and June, it is to be expected that more seed would be dispersed to the northern side of each planted strip.

The greater spread of plants from strips 3 and 4 compared with strips 1 and 2 suggests that the soil from the former site, which contained a greater proportion of fine particles, was more favourable for buffel grass than that from the latter site.

The trial design placed limitations on the type of statistical analysis that could be conducted. This, together with the considerable variability in the pattern of spread resulting from the above-mentioned influences of trees and logs, soil variation and wind direction, increased the difficulties of interpretation of results. Consequently, it was not possible to show statistical significance for the apparent effect of proximity to the river on plant populations from strips 3 and 4. This effect did not occur with strips 1 and 2. In a few instances, spread was greater on the southern side of strips and it is conjectured that the northern drift of seed eventually allowed build up on the southern side of adjacent planted strips.

Rainfall is a major factor controlling the establishment of plants, but the most important components of rainfall can be difficult to define. Information obtained on a clay loam soil at Katherine in the Northern Territory suggests that successful emergence of buffel grass was obtained when sowing was followed by rain which maintained the top 15 cm of soil above wilting point for 5 to 6 days (Norman 1960). A similar situation could be expected at Cloncurry where it is popularly held that, when favourable rainfall is recorded for several consecutive days, the probability of buffel grass establishment is high. Although conditions suitable for establishment occurred during the 10-year period, the location of the trial area precluded the collection of accurate rainfall and germination data during the summer months. Consequently, the only measure of germination response was that provided by the end of season density estimates.

The lack of colonization over the first 4 years and the large increases in 1963 and 1964 cannot be related to any obvious rainfall differences. It is reasonable to suggest that a build-up of viable seed in the soil is necessary before worthwhile spread can occur. Only a proportion of the total seed produced is available for germination; much is destroyed by seed-harvesting ants (Champ, Sillar and Lavery 1961). Under central Australian conditions, the viability of seed incorporated in the soil for 12 months fell to 12% (Winkworth 1963). Seed buried for 3 years, however, retained 10% viability. Thus, ungerminated buried seed could accumulate from year to year.

As plant density increases, a point must be reached above which establishment would be restricted by competition from mature plants. It is suggested that the population decline which occurred in the tenth year indicates that the high population reached in the previous year could not be sustained in this environment. By this time, the planted strips were no longer obvious.

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