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EFFECT OF INITIAL DENSITY OF HUNTER RIVER LUCERNE ON PRODUCTIVITY AND PERSISTENCE OF HUNTER RIVER LUCERNE ALONE AND WITH PETRIE GREEN PANIC IN SWARDS

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SUMMARY

Increasing Hunter River density raised its yield for 3 years. At that time, two common low Hunter River densities, without and with Petrie, had resulted. Greater Hunter River density initially depressed both Petrie and total yields but thereafter increased them. For the first 4 years, Hunter River and weed yields were lower in the mixed swards. Total yield was initially lower but was later equal or higher in the Hunter River swards.

Where Petrie only was planted, total yield after 2 years was lower than in the other treatments.

Yield of a forage sorghum crop planted on the experimental area at conclusion of the experiment was lowest in the sections which had carried Petrie only.

I. INTRODUCTION

The value of *Medicago sativa* cv. Hunter River as a legume component of mixed pastures in subtropical Queensland was reported by Christian and Shaw (1952), Young, Fox and Burns (1959) and Young and Daly (1967). The lastmentioned authors found that Hunter River persistence was poor and production declined 3 years after sowing under less favourable rainfall.

Supplementing native pasture with grazing Hunter River has been responsible for increased liveweight gains of steers at "Brian Pastures" Pasture Research Station (Anon. 1963) and greater wool yield of wethers at Texas, south-eastern Queensland (Lee and Rothwell 1966).

The effects of initial Hunter River density on productivity and persistence of Hunter River planted with and without *Panicum maximum* var. *trichoglume* cv. Petrie are reported here.

II. MATERIALS AND METHODS

The experiment was carried out at "Brian Pastures" Pasture Research Station near Gayndah in subtropical and sub-coastal Queensland. The station has an average annual rainfall of 700 mm. The soil was a dark grey-brown sandy-clay (Ug6 (Northcote 1965)) of moderate fertility fallowed for weed control for 10 months before sowing.

Treatments involved Hunter River densities of 2·5, 7·4, 22·2, 67·7 and 200·1 plants/m^2 with and without Petrie at a standard density of 24·7 plants/m^2. A 'control' treatment of Petrie alone at the standard density was included. The experiment was a randomized block design with five replications of 11 treatments. Plot size was 3 m x 3 m.

Petrie and Huner River were hand-broadcast and raked into a well-prepared seedbed at 33 and 9 kg/ha respectively on 23.ii.62. Hunter River seed was inoculated with the appropriate rhizobia before sowing. Plots were hand-thinned by replications between 19.iii.62 and 14.iv.62 to give an even distribution of plants at the desired densities.

Plots were either heavily grazed overnight or mown to a stubble height of 5 cm between one and four times per year with a mean of 2¼ defoliations per year for the 8 years of the experiment. Periodic sampling of the pasture for density and basal cover and yield dynamics at intervals of 2 years are reported. Three 100 cm x 40 cm random pasture samples in each plot were cut for yield to a stubble height of approximately 1·3 cm. These were separated into Petrie, Hunter River and weed, dried at 93°C in a forced-draught oven for 16 hr, and weighed.

Density of sown species per plot was obtained from 10, 6 and 25 100 cm x 40 cm quadrats in 1962, 1964 and 1965 respectively, and in 1967 and 1968 from four 100 cm x 100 cm quadrats. The lowest Hunter River density plots were rethinned to the treatment density of 2·5 plants/m^2 on 6.ii.63. Accurate density estimates for Petrie in the mixed swards were only possible up to that of 13.x.65. Percentage basal cover of Petrie, Hunter River, native *Dichanthium* species and other species was recorded on 1.xii.69 using a point quadrat with five points spaced 10·2 cm apart. Two hundred and fifty points were recorded per plot.

Plots were cultivated and a seedbed prepared on 1.xii.69. *Sorghum vulgare* cv. Sugardrip was then sown at 17 kg/ha in 15 cm drills and superphosphate applied at 220 kg/ha.

On 2.iii.70 a strip of sorghum 200 cm x 100 cm was cut to ground level in each plot. The cut material was chaffed, dried at 93°C in a forced-draught oven for 48 hr, and weighed.

III. RESULTS

The results are shown in Tables 1-8.

At the sampling on 5.v.62, Petrie yield decreased and Hunter River yield increased with greater Hunter River density (Table 1). Hunter River and weed yields were lower and total yield was higher in the mixed swards. Higher density caused an increase in total yield in the absence of grass and the reverse in the presence of grass producing a significant ($P < 0{\cdot}01$) density x grass interaction. Total yield of the control was greater than for the Hunter River only swards and for the two highest Hunter River density mixed pastures.

TABLE 1

DRY-MATTER ACCUMULATION FROM SOWING TO 15.V.62 (KG/HA)

Hunter River Density (plants/m²)	Without Grass			With Grass				Density Means		
	Hunter River	Weed	Total	Petrie	Hunter River	Weed	Total	Hunter River	Weed	Total
Control ..				2,560	..	90	2,640			
2·5 ..	100	260	360	3,020	20	120	3,170	60	190	1,770
7·4 ..	240	240	480	2,710	50	10	2,760	150	120	1,620
22·2 ..	390	230	620	2,260	150	40	2,460	270	140	1,540
67·7 ..	670	240	920	1,480	300	30	1,820	490	140	1,370
200·1 ..	940	40	990	880	580	20	1,490	760	40	1,240
Means ..	470	200	670		220	40	2,340			

	L.S.D. $P = 0{\cdot}05$	L.S.D. $P = 0{\cdot}01$
Petrie means	980	1,340
Hunter River—		
density means	110	140
grass means	70	90
Weed grass means	90	120
Total—		
grass means	330	430
density x grass means	730	960
treatments *v*. control means	730	960

At the sampling on 7.x.64, Petrie and Hunter River yields increased and weed yield decreased with higher Hunter River densities (Table 2). These had a greater effect on increasing Hunter River yield in the legume only than in the mixed swards resulting in a significant ($P < 0{\cdot}01$) density x grass interaction. Hunter River and weed yields were depressed by Petrie. The decrease in weed yield with increasing legume density was greater in the legume than in the mixed swards and produced a significant ($P < 0{\cdot}01$) density x grass interaction. Weed yield of the control was lower than in the lower density legume swards. Total yield in the legume swards decreased and in the mixed pasture increased, producing a significant ($P < 0{\cdot}01$) density x grass interaction. Total yield of the control was lower than in either the legume-only stands or the higher density mixed swards.

TABLE 2

DRY-MATTER ACCUMULATION FROM 10.iii.64 TO 7.x.64 (KG/HA)

Hunter River Density (plants/m^2)	Without Grass			With Grass				Density Means		
	Hunter River	Weed	Total	Petrie	Hunter River	Weed	Total	Hunter River	Weed	Total
Control ..				720	..	70	800			
2·5 ..	640	960	1,600	620	190	40	840	420	500	1,220
7·4 ..	720	470	1,190	790	250	50	1,090	480	260	1,140
22·2 ..	750	280	1,030	1,190	240	30	1,460	500	150	1,240
67·7 ..	1,040	130	1,170	1,160	370	20	1,560	700	80	1,360
200·1 ..	1,220	40	1,260	1,070	160	10	1,240	690	20	1,250
Means ..	870	380	1,250		240	30	1,240			

	L.S.D. $P = 0{\cdot}05$	L.S.D. $P = 0{\cdot}01$
Petrie means	320	430
Hunter River—		
density means	110	150
grass means	70	90
density x grass means	160	210
Weed—		
density means	140	180
grass means	80	110
density x grass means	190	250
treatments v. control means	190	250
Total—		
density x grass means	350	460
treatments *v*. control means	350	460

At the sampling on 17.x.66, Hunter River weed and total yields of the legume-only swards were higher than for the mixed swards (Table 3). Weed yield in the control was less than in the legume swards and total yield of the control was less than in the other pastures. The percentage Petrie in the weed yield of the legume swards increased as the legume density increased up to the second highest legume density.

At sampling on 21.ii.68 (Table 4) and 19.xi.69 (Table 5) weed yield was greater in the legume than in the mixed swards and total yield of the control was lower than in the other treatments. The percentage of Petrie in the weed yield of the legume swards increased as the Hunter River density increased.

TABLE 3

DRY-MATTER ACCUMULATION FROM 16.vi.66 TO 17.x.66 (KG/HA)

Hunter River Density (plants/m²)	Without Grass			With Grass				Density Means		
	Hunter River	Weed	Total	Petrie	Hunter River	Weed	Total	Hunter River	Weed	Total
Control ..				700	..	200	910			
2·5 ..	510	980 (30)	1,490	710	310	90	1,120	410	540	1,300
7·4 ..	830	950 (60)	1,790	760	640	50	1,460	740	500	1,620
22·2 ..	620	890 (60)	1,510	840	420	90	1,340	520	490	1,420
67·7 ..	660	800 (80)	1,460	840	450	20	1,310	560	410	1,390
200·1 ..	590	700 (30)	1,300	840	320	80	1,240	460	390	1,270
Means ..	640	870	1,510		430	70	1,290			

( ) % Petrie in weed yield.

	L.S.D. $P = 0{\cdot}05$	L.S.D. $P = 0{\cdot}01$
Hunter river grass means	160	210
Weed—		
grass means	120	160
treatments v. control means	270	350
Total—		
grass means	180	240
treatments *v*. control means	410	530

TABLE 4

DRY-MATTER ACCUMULATION FROM 13.xii.67 TO 21.xi.68 (KG/HA)

Hunter River Density (plants/m²)	Without Grass			With Grass				Density Means		
	Hunter River	Weed	Total	Petrie	Hunter River	Weed	Total	Hunter River	Weed	Total
Control ..				290	..	1,820	2,110			
2·5 ..	470	2,300 (20)	2,700	890	400	1,550	2,840	430	1,920	2,800
7·4 ..	740	2,110 (30)	2,850	950	900	1,310	3,160	820	1,710	3,000
22·2 ..	700	2,790 (20)	3,490	1,030	270	1,480	2,770	480	2,130	3,130
67·7 ..	570	3,380 (50)	3,950	1,240	820	960	3,020	700	2,170	3,490
200·1 ..	640	3,390 (50)	4,030	1,470	490	1,370	3,330	570	2,380	3,680
Means ..	620	2,790	3,420		570	1,330	3,020			

( ) % Petrie in weed yield

	L.S.D. $P = 0{\cdot}05$	L.S.D. $P = 0{\cdot}01$
Weed grass means	450	590
Total treatments *v*. control means	1,030	1,360

TABLE 5

DRY-MATTER ACCUMULATION FROM 24.iv.69 TO 19.xi.69 (KG/HA)

Hunter River Density (plants/m²)	Without Grass			With Grass				Density Means		
	Hunter River	Weed	Total	Petrie	Hunter River	Weed	Total	Hunter River	Weed	Total
Control ..				100	..	600	690			
2·5 ..	0	890 (20)	890	470	0	450	920	0	670	900
7·4 ..	0	880 (40)	880	540	0	350	880	0	610	880
22·2 ..	0	980 (40)	980	440	0	380	830	0	680	900
67·7 ..	0	1,130 (60)	1,130	630	0	320	950	0	720	1,040
200·1 ..	0	900 (40)	900	410	0	500	910	0	700	900
Means ..	0	950	960		0	400	900			

( ) % Petrie in weed yield

	L.S.D. $P = 0·05$	$P = 0·01$
Petrie means	270	370
Weed grass means	120	160
Total treatments *v*. control means	230	300

The yield of sorghum was lower in the control than in the other treatments (Table 6).

TABLE 6

SORGHUM DRY-MATTER YIELDS ON 2.iii.70 (KG/HA)

Hunter River Density (plants/m²)	Without Grass	With Grass	Density
Control	—	4,900	
2·5	6,030	5,860	5,940
7·4	6,870	6,830	6,850
22·2	6,690	6,670	6,680
67·7	6,870	6,680	6,780
200·1	6,780	5,960	6,370
Means	6,490	6,400	

	L.S.D. $P=0·05$	$P=0·01$
Treatment *v*. control means ..	1,130	1,490

Up to 1965, Hunter River density was in accordance with its original density (Table 7). In 1964 the higher legume density as its original density increased was greater in the legume swards and resulted in a significant ($P < 0·01$) density x grass interaction. In 1964, 1965 and 1967 Hunter River density was higher in the legume stands. In 1969 Hunter River density showed no significant differences between treatments.

TABLE 7

LUCERNE DENSITY (PLANTS/M²)

Date	WITHOUT GRASS					WITH GRASS					DENSITY MEANS				
	3.x.62	23.iii.64	13.x.65	21.vii.67	18.xi.69	3.x.62	23.iii.64	13.x.65	21.vii.67	18.xi.69	3.x.62	23.iii.64	13.x.65	21.vii.67	18.xi.69
Hunter River Density (plants/m²)															
2·5	7·4*	4·0	13·8	6·2	0·7	6·9*	2·5	11·4	2·7	0·2	7·2	3·2	12·6	4·5	0·4
7·4	10·6	8·6	14·6	5·9	0·2	8·2	3·7	10·9	3·5	0·2	9·4	6·2	12·8	7·7	0·2
22·2	23·0	13·1	15·1	8·2	0·5	22·5	4·7	6·4	2·2	0·2	22·7	9·0	10·8	5·3	0·3
67·7	72·6	22·5	16·3	4·7	0·6	64·2	5·4	8·2	8·2	0·4	68·3	14·0	12·3	4·1	0·5
200·1	171·2	25·9	16·8	5·4	0·5	172·4	7·2	7·9	3·2	0·4	171·9	16·5	12·4	4·3	0·5
Means	57·1	14·8	15·3	6·1	0·5	54·8	4·7	8·9	3·1	0·3					

* Hunter River re-thinned to required density of 2·5 pl/m² on 6.xi.63 after the first density count.

			LSD $P = 0{\cdot}05$	LSD $P = 0{\cdot}01$
3.x.62	:	density means	8·1	16·6
24.ii.64	:	density means	4·2	5·5
	:	grass means	2·7	3·5
	:	density x grass means	5·9	7·8
13.x.65	:	grass means	4·4	5·7
21.vii.67	:	grass means	1·7	2·2
18.xi.69			N.S.	

TABLE 8

PERCENTAGE BASAL COVER OF PASTURE COMPONENTS ON 1.iii.69

Hunter River Density (plants/m²)	WITHOUT GRASS				WITH GRASS				DENSITY MEANS			
	Petrie	Dichanthium	Other Species	Total	Petrie	Dichanthium	Other Species	Total	Petrie	Dichanthium	Other Species	Total
Control					0·6	2·6	0·2	3·4				
2·5	1·0	2·0	0·0	3·0	1·8	2·0	0·2	3·9	1·4	2·0	0·1	3·4
7·4	1·3	1·1	0·2	2·6	1·5	1·9	0·2	3·7	1·4	1·5	0·2	3·1
22·2	1·0	2·0	0·2	3·3	1·9	2·6	0·1	4·6	1·5	2·3	0·2	4·0
67·7	2·6	1·9	0·4	5·0	4·4	1·8	0·2	6·3	3·5	1·8	0·3	5·6
200·1	2·3	1·2	0·3	3·8	2·0	2·7	0·2	4·9	2·2	2·0	0·2	4·4
Means	1·6	1·6	0·2	3·5	2·3	2·2	0·2	4·7				

No hits were recorded on lucerne in any plot.

		LSD $P = 0{\cdot}05$	LSD $P = 0{\cdot}01$
Petrie	: density means	1·2	1·5
	: treatment *v.* control means	1·7	2·2
Total	: density means	1·2	1·6
	: grass means	0·8	1·0

Individual original plants of Petrie were recognizable for the first three density counts and to this time original Petrie density was maintained in all treatments. Subsequently Petrie plants either started to die from the centre outwards and formed peripheral individual crowns or died out completely.

Mean Petrie and total basal cover in the 67·7 plants/m^2 treatments were higher than in the other Hunter River density treatments (Table 8). The lowest cover of Petrie was in the control. The total basal cover was greater for the mixed than for the legume swards. A zero Hunter River basal cover was recorded in all plots.

IV. DISCUSSION

The initial effect of increasing Hunter River density in both the legume and mixed pastures was to increase the yield of Hunter River. Donald (1951) for the annual legume subterranean clover (*Trifolium subterraneum* L.) and Jarvis (1962) for lucerne showed that yield of dry matter was constant or increased only slightly from moderate to high densities and there was no reduction in dry matter per unit area even in extremely dense swards. The Hunter River densities used in the study reported here were at the lower end of the ranges investigated by these authors and the highest Hunter River density used was equivalent to a moderate level. Jarvis (1962) showed that plant population had a very considerable effect on yield up to a level of 190 plants/m^2 but little further increase in yield resulted when the population was increased beyond that point. In the mixed swards, increasing Hunter River density initially caused a marked reduction in Petrie and total yields. Hunter River weed yields were lower and total yield was higher in the mixed swards.

After 2 years, both legume and Petrie yields increased with increasing Hunter River density. The effect on total yield, particularly in the legume swards, was offset by a decrease in weed yield as Hunter River density increased. Total yield of the control was lower than in the legume swards and the higher density mixed swards. Cameron and Mullaly (1969) measured an increase in grass and total dry-matter yields in infrequently grazed grass-lucerne swards due to the inclusion of lucerne. The pastures were grown on a deep grey-brown clay-alluvial soil and measurements commenced 18 months after sowing. On a shallow basaltic-derived grey-brown sandy-clay soil in a similar environment, Scateni (1968) reported little effect of lucerne on grass and total yield for the period from 6 to 15 months after sowing.

The loss of Hunter River plants in the first 3 years of the experiment was considerable at the high populations but negligible or showed an increase at the low ones. This is in agreement with the results reported by Jarvis (1962). Two common Hunter River densities without and with Petrie had resulted 3 years after sowing. Subsequently Hunter River densities declined to very low levels.

The effects of Hunter River on Petrie dry-matter yield, invasion of legume plots and percentage basal cover after the early years of the experiment were probably due to the nitrogen contribution of the legume, which increased as the Hunter River density increased. However, Hunter River did not maintain a productive and closed Petrie stand and all mixed swards suffered considerable invasion by native grasses.

The results of the experiment indicate that for rain-grown Hunter River swards in this environment, a Hunter River density of 70 plants/m^2 equivalent to a seeding rate of about 4 kg/ha, assuming 90% germination and 40% establishment of pure live seed, would give optimum Hunter River production, persistence and beneficial effect on a subsequent crop. The situation with grass-Hunter River pastures is less clear. Where maximum lucerne yields and optimum persistence of the sown grass (without nitrogen fertilizer) are the aims, a Hunter River density of 70 plants/m^2 would also be optimum. However, where the aim is maximum early total dry-matter production from the sward, the results suggest that a much lower density of approximately 8 plants/m^2 would be required.

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