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STUDIES WITH A RANGE OF GRASS CULTIVARS IN SMALL PLOTS AT BILOELA, CENTRAL QUEENSLAND

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SUMMARY

Over a period of 5 years *Panicum coloratum* var. *makarikariense* cv. Bambatsi and cv. Burnett yielded well in midsummer each year but made little growth over winter, though they remained green.

***Cenchrus ciliaris* cv. Molopo had the best winter growth and highest quality standover feed in one experiment. In old stands, however, its frost tolerance was poor. It is suggested that this may have been due to low mineralization of soil nitrogen. In all but the establishment season the buffel grasses gave higher dry-matter yields than the *P. maximum* cultivars, Petrie and Gatton. Quality of the buffels in terms of both nitrogen and phosphorus was, however, poorer.**

***Chloris gayana* cv. Callide and Petrie and Gatton panics were much better utilized than *C. gayana* cv. Pioneer, while utilization of the buffel cultivars Molopo and Biloela was intermediate.**

***P. coloratum* cv. Bambatsi and cv. Burnett were unaffected by partial flooding. This flooding severely affected most of the buffel grasses and to a lesser extent Petrie and Gatton panics. Bambatsi and Burnett panics and *Digitaria smutsii* were slow to establish.**

I. INTRODUCTION

The three grasses most commonly used in sown pastures in subcoastal Central Queensland are Rhodes grass (*Chloris gayana* Kunth cv. Pioneer), green panic (*Panicum maximum* var. *trichoglume* (K. Schum.) Eyles cv. Petrie) and buffel grass (*Cenchrus ciliaris* L. cv. Biloela). In recent years, however, further cultivars of these or closely related species have become available. There is little information regarding their comparative performances.

This paper presents results from a series of small-plot comparisons carried out at the Biloela Research Station of the Queensland Department of Primary Industries.

II. MATERIALS AND METHODS

Details of three experiments located on Unit 5 of the Kroombit Land System (Perry 1968) are presented. This land system is made up of alluvial plains originally with eucalypt woodland. Unit 5 is the back plains with deep texture-contrast soils. Major climatic features for the period of these experiments are shown in Table 1.

TABLE 1

MAJOR CLIMATIC FEATURES MEASURED AT METEOROLOGICAL ENCLOSURE, BILOELA RESEARCH STATION

—	J	F	M	A	M	J	J	A	S	O	N	D	Total
						Rainfall (in.)							
1963	3·75	1·51	6·36	0·61	0·41	0·50	0·02	3·12	0·14	0·27	1·22	4·64	22·55
1964	4·02	1·34	0·25	0·51	0·81	1·07	3·96	1·29	2·56	4·53	1·17	4·38	25·89
1965	6·72	0·21	1·76	4·01	0·19	1·00	0·05	0·14	1·17	0·59	1·26	5·33	22·43
1966	2·83	2·23	5·28	1·03	0·84	2·91	1·35	2·78	0·93	3·11	2·80	5·54	31·63
1967	3·39	2·02	0·47	0·20	0·94	4·45	0·94	1·48	0	3·20	4·17	9·19	30·45
1968	7·83	3·60	4·18	2·21	2·08	0·0	1·05	0·97	0·90	0·55	3·91	2·29	29·57
Mean 1924–1967	4·14	4·52	2·68	1·62	1·48	1·59	1·31	0·81	0·84	2·06	2·80	3·88	27·73
						Mean Maximum Temperature (°F)							
1963	88·2	93·3	88·4	81·7	79·1	72·2	71·4	74·6	82·5	83·9	88·8	89·5	
1964	93·0	90·2	89·8	86·4	79·1	71·7	71·5	76·5	79·9	82·2	88·4	92·5	
1965	93·3	92·6	89·4	85·0	78·2	74·0	69·1	77·1	83·4	85·8	94·1	87·0	
1966	89·3	94·0	90·0	86·9	77·4	73·6	70·7	72·3	81·0	82·4	88·5	91·1	
1967	94·6	90·9	88·4	84·8	77·9	70·8	69·3	72·1	81·3	87·2	88·3	88·2	
1968	92·3	86·8	86·3	87·0	73·7	72·4	69·3	74·2	78·8	88·1	92·1	91·7	
Mean 1925–1967	91·2	89·3	87·6	83·4	77·1	71·6	70·1	74·6	80·5	85·6	88·9	90·7	
						Mean Minimum Temperature (°F)							
1963	65·9	66·0	70·1	57·9	49·4	41·2	32·6	48·5	44·6	52·4	58·5	62·5	
1964	66·9	68·1	64·6	59·5	53·3	45·3	42·0	39·7	51·7	53·0	57·2	65·8	
1965	65·7	62·0	61·4	58·5	48·5	44·2	33·2	42·5	50·3	56·9	61·3	66·1	
1966	65·1	66·8	62·0	54·7	43·8	47·4	39·3	47·4	53·3	49·1	60·3	64·2	
1967	69·4	65·8	63·4	56·8	48·7	51·7	44·2	40·7	42·8	57·1	59·9	72·4	
1968	66·0	65·9	62·4	55·2	50·6	39·1	42·7	41·2	49·1	54·8	61·8	63·6	
Mean 1925–1967	66·8	66·4	64·4	55·1	47·6	43·5	40·2	41·1	42·1	54·9	60·4	64·2	
						Mean Terrestrial Minimum Temperature (°F)							
1963	60·6	60·5	64·5	52·5	43·1	35·1	25·8	44·1	37·8	47·0	55·4	59·1	
1964	63·2	64·6	60·7	54·3	45·5	39·6	37·2	32·3	47·8	47·7	55·7	59·1	
1965	61·5	56·8	58·1	55·5	43·9	36·5	24·7	35·8	44·3	49·5	57·0	61·4	
1966	63·5	60·8	53·3	49·3	36·1	37·9	29·9	37·6	39·3	43·4	52·7	52·4	
1967	58·2	58·7	57·2	51·5	44·2	47·6	37·1	33·6	32·9	53·0	56·0	57·5	
1968	62·6	62·3	57·7	48·3	50·1	33·9	37·1	36·4	42·9	48·9	57·5	60·5	
Mean 1925–1967	63·6	63·3	59·5	51·8	43·6	39·2	35·5	36·0	37·7	49·7	56·7	60·4	

Experiment 1 was sown on March 7, 1963, as a 6 x 2 x 4 randomized block with six grass cultivars—Pioneer Rhodes, Callide Rhodes, Biloela buffel, Molopo buffel, Petrie green panic and Gatton panic—in simple combinations with two legumes, *Medicago sativa* L. cv. Hunter River and *Phaseolus atropurpureus* DC. cv. Siratro. The effects of Hunter River lucerne on the mean before-grazing grass and legume yields and grass nitrogen contents were presented from this experiment by Cameron and Mullaly (1969*a*).

Post-grazing harvests were also taken on a number of occasions to measure the relative utilization of the various cultivars. The cuttings were made in February 1964, February 1965, June 1965, February 1966, March 1967, November 1967 and June 1968.

Experiment 2 was planted as an 11 x 6 randomized block design with 30 lk x 40 lk plots on December 28, 1962. Grasses sown at 3 lb/ac with inoculated Hunter River lucerne seed at 2 lb/ac were *Cenchrus ciliaris* cultivars Biloela, Molopo, Nunbank, Lawes and Tarewinnabar; *Digitaria smutsii* Stent Q. 5390; *Panicum maximum* var. *trichoglume* cv. Petrie; *Panicum maximum* Jacq. cv. Gatton; *Panicum coloratum* L. Q 4901; and *P. coloratum* var. *makarikariense* Goosens cultivars Bambatsi and Burnett.

Periodic harvests were made by cutting one 16 ft strip from each plot with either a 3 ft or a 4 ft mower, after which the area was grazed by dairy cattle and slashed to 3 in. in height. On March 22, 1963, ten days after the initial harvest, plant populations were determined by counting three 5 lk x 2 lk quadrats within the mower strip on each plot. To determine relative frost tolerance of a number of cultivars following the severe 1963 winter, two randomly selected plants per plot were cut on August 14, 1963, and leaf material separated into green and dead, oven-dried, weighed and bulk samples from each category for each cultivar analysed for crude protein.

In late December 1964 and again in January 1966 the trial area was partially flooded by heavy rain to 2–3 in. depth for some weeks. This reduced the value of subsequent dry-matter results considerably, but an examination of the other species and inert separates at the harvest made on February 15, 1965, provides a useful guide to the relative effects of the initial flooding.

Experiment 3 was planted on January 26, 1965, as a 4 x 6 x 3 randomized block design with 65 ft x 33 ft plots to study the effects of frost on four grasses and six legumes in simple mixtures, in terms of the quantity and quality of standover forage in late winter. A severe infestation of black pigweed (*Trianthema portulacastrum* L.) caused complete failure of legume establishment. Grass establishment from a sowing of 3 lb/ac of each was adequate. This gave 18 plots of each grass in three blocks of six.

The grasses planted were Biloela buffel, Molopo buffel, Petrie green panic and Bambatsi panic.

Although the original experiment was abandoned it was possible to record differences in the reaction of grasses to frost in 1966 and 1967.

TABLE 2

EFFECT OF GRASS CULTIVARS ON COMPONENTS OF BEFORE GRAZING YIELDS OF EXPERIMENT 1
Yield attributes—lb/ac oven-dry

Year	1	2		3			4		5			
Cultivar	5.ii.64	21.i.65	19.v.65	7.xii.65	10.ii.66	27.vi.66	20.x.66	13.ii.67	22.xi.67	31.i.68	7.v.68*	Total
GRASS												
Molopo buffel	3,699	1,630	1,323	198	2,951	840	587	1,886	657	3,279	2,533	19,583
Biloela buffel	3,100	1,333	1,595	151	3,188	702	285	1,969	745	3,187	1,565	17,830
Pioneer Rhodes	3,751	1,091	568	66	1,078	176	149	1,259	75	1,721	1,611	11,545
Callide Rhodes	3,094	1,060	850	61	1,057	166	38	1,208	82	1,830	1,686	11,132
Petrie green panic	2,132	706	801	49	1,659	263	144	1,099	296	2,121	1,040	10,310
Gatton panic	184	506	670	77	2,533	239	142	872	334	2,352	552	8,461
L.S.D. 5%		478	271	44	898	190	125	617	227	1,137	682	
L.S.D. 1%		643	365	59	1,207	255	168	829	306	1,528	916	
SOWN LEGUME												
Gatton panic	393	503	357	201	204	83	532	145	691	604	755	4,468
Pioneer Rhodes	113	237	243	88	374	127	504	126	871	907	389	3,979
Biloela buffel	176	346	247	94	169	86	627	70	771	612	463	3,661
Callide Rhodes	55	255	244	28	518	108	507	89	896	558	183	3,441
Molopo buffel	141	280	312	87	214	42	379	77	568	420	446	2,966
Petrie green panic	76	175	154	72	242	120	474	107	511	452	316	2,699
L.S.D. 5%		276	212	73	202	Not Analysed	Not Analysed	Not Analysed	381	Not Analysed	Not Analysed	
L.S.D. 1%		371	284	98	272				512			

OTHER SPECIES AND INERT												
Gatton panic	1,611	380	378		998	353	175	967	107	965	1,292	7,226
Pioneer Rhodes	74	176	198		468	214	86	238	125	1,528	712	3,819
Callide Rhodes	30	229	235		167	153	61	242	60	1,096	363	2,636
Petrie green panic	103	200	128		188	167	53	309	48	807	364	2,367
Molopo buffel	157	198	172		133	244	58	219	47	211	457	1,896
Biloela buffel	174	158	140		153	266	67	191	49	617	482	2,297
L.S.D. 5%	Not	174	115		414	126	86	395	56	621	590	
L.S.D. 1%	Analysed	234	155		556	169	116	531	75	934	793	
TOTAL DRY MATTER												
Molopo buffel	3,999	2,109	1,807	285	3,244	1,147	1,315	2,302	1,272	3,991	3,437	24,908
Biloela buffel	3,460	1,837	1,982	245	3,510	1,075	1,321	2,293	1,565	4,467	2,510	24,265
Gatton panic	2,189	1,389	1,405	279	3,735	694	1,124	2,094	1,133	3,965	2,319	20,326
Pioneer Rhodes	3,938	1,504	1,009	155	1,919	562	1,108	1,732	1,071	4,163	2,712	19,873
Callide Rhodes	3,179	1,543	1,329	89	1,742	523	1,132	1,658	1,038	3,484	2,233	17,950
Petrie green panic	2,262	1,081	1,083	121	2,089	574	898	1,539	855	3,381	1,720	15,603
L.S.D. 5%	835	673	408	88	1,072	243	435	643	522	1,149	1,074	
L.S.D. 1%	1,122	904	548	118	1,441	327	585	863	701	1,544	1,443	

* Sown legume yield is mean of sown lucerne, siratro and invading lucerne yield in siratro plots.

TABLE 3

EFFECTS OF GRASS CULTIVARS ON ANNUAL YIELDS AND YIELD COMPONENTS IN EXPERIMENT 2
lb/ac oven-dry matter

Cultivar	Pre-flooding			Post-flooding		Total Yield
	1st year	2nd year	3rd year	4th year	5th year	
GRASS						
Burnett buffel	1,412	5,197	7,932	4,467	2,884	21,891
Tarewinnabar buffel ..	2,133	2,847	5,683	4,655	2,369	17,687
Molopo buffel	1,566	3,553	6,176	4,129	2,223	17,687
Bambatsi panic	307	3,339	6,852	4,529	2,355	17,381
Panicum coloratum Q4901	1,395	3,961	6,349	3,336	1,795	16,841
Biloela buffel	1,313	3,055	5,299	4,419	1,966	16,051
Petrie green panic ..	4,581	3,205	3,925	2,486	894	15,087
Nunbank buffel	1,947	2,960	4,588	3,953	1,394	14,842
Digitaria smutsii	17	3,957	5,560	3,790	1,329	14,652
Lawes buffel	2,812	2,889	4,382	2,945	1,430	14,461
Gatton panic	5,280	2,428	2,702	1,779	601	12,892
L.S.D. 5%	1,018	Not	2,498	1,233	994	4,850
L.S.D. 1%	1,358	Analysed	3,330	1,644	1,325	6,466
LUCERNE						
Biloela buffel	21	88	1,497	3	92	1,702
Molopo buffel	46	384	972	..	91	1,493
Lawes buffel	31	316	950	65	113	1,476
Nunbank buffel	21	357	1,048	..	38	1,464
Burnett panic	57	33	1,257	..	8	1,354
Panicum coloratum Q4901	19	38	1,216	..	60	1,333
Digitaria smutsii	90	134	1,055	7	2	1,288
Gatton panic	11	175	849	100	143	1,279
Tarewinnabar buffel ..	33	257	857	11	36	1,195
Bambatsi panic	46	207	895	7	27	1,181
Petrie green panic ..	26	44	675	58	106	909
L.S.D. 5%	27	Not	1,607	Not	Not	608
L.S.D. 1%	35	Analysed	2,143	Analysed	Analysed	811
OTHER SPECIES AND INERT						
Biloela buffel	549	2,743	4,708	1,289	2,214	11,503
Lawes buffel	274	3,111	3,990	1,221	2,123	10,722
Nunbank buffel	193	2,638	3,914	1,163	2,658	10,566
Tarewinnabar buffel ..	435	2,257	3,086	759	1,637	8,173
Molopo buffel	349	2,352	2,517	989	1,673	7,880
Burnett panic	675	1,357	2,460	729	1,878	7,099
Digitaria smutsii	935	677	3,012	565	1,669	6,858
Bambatsi panic	748	1,498	1,720	926	1,836	6,725
Panicum coloratum Q4901	457	1,414	1,846	222	1,040	5,180
Petrie green panic ..	157	791	1,223	611	2,204	4,986
Gatton panic	255	700	789	565	2,153	4,464
L.S.D. 5%	Not	Not	1,607	756	1,095	2,638
L.S.D. 1%	Analysed	Analysed	2,143	1,009	1,460	3,518

TABLE 3—continued

EFFECTS OF GRASS CULTIVARS ON ANNUAL YIELDS AND YIELD COMPONENTS IN EXPERIMENT 2
lb/ac oven-dry matter

Cultivar	Pre-flooding			Post-flooding		Total Yield
	1st year	2nd year	3rd year	4th year	5th year	
TOTAL DRY MATTER						
Burnett panic	2,144	6,587	11,648	5,170	4,770	30,319
Biloela buffel	1,883	5,886	11,504	5,711	4,272	29,256
Tarewinnabar buffel ..	2,602	5,361	9,627	5,425	4,042	27,056
Molopo buffel	1,961	6,289	9,664	5,118	3,988	27,021
Nunbank buffel	2,161	5,955	9,549	5,116	4,090	26,871
Lawes buffel	3,118	6,323	9,322	4,232	3,666	26,660
Bambatsi panic	1,098	5,043	9,465	5,461	4,218	25,285
Panicum coloratum Q4901	1,871	5,418	9,410	3,759	2,896	23,353
Digitaria smutsii	1,041	4,767	9,627	4,362	3,001	22,799
Petrie green panic ..	4,763	4,036	5,823	3,155	3,204	20,982
Gatton panic	5,646	3,307	4,340	2,444	2,896	18,635
L.S.D. 5%	1,161	1,253	2,073	934	911	3,888
L.S.D. 1%	1,548	1,671	2,763	1,245	1,215	5,183

On September 6, 1966, a 16 ft x 3 ft mower strip was harvested from two plots of each grass and weighed in the field. Total dry matter was determined without separation and a subsample used for determination of nitrogen content. The material harvested was accumulated growth from the previous December.

The area was grazed intermittently from September 1966 to May 2, 1967, when it was slashed to approximately 3 in. above ground level. Animals were excluded for the winter. On dates approximately 1 month apart (June 28, August 2 and September 5), four 42 in. x 21 in. quadrats were selected at random and cut to slashing height in each grass plot of one block of the original experiment. In June only green leaf was collected but in August and September green and frosted growth was collected and oven-dry yields of each component were determined. The September harvest is a measure of total winter growth.

III. RESULTS

(a) Dry-matter Yields

Dry-matter yields obtained from experiment 1 at each harvest are shown in Table 2 and annual pasture dry-matter totals for experiment 2 are presented in Table 3.

Grass yield was the overriding determinant of total dry-matter yield in each experiment. In experiment 1 the initial growth in autumn 1963 was not measured and from the beginning of 1965 onwards the two buffel grasses

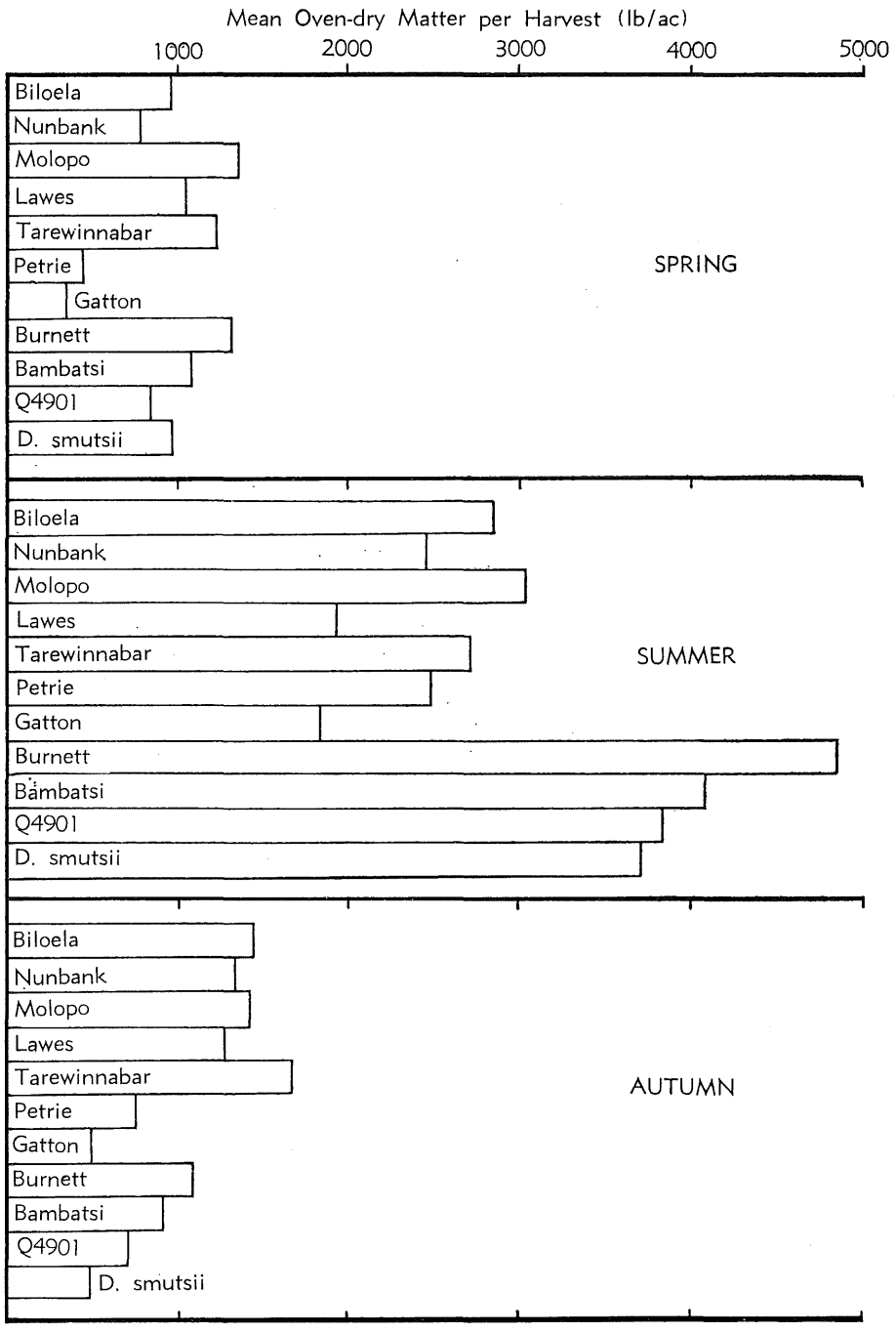

Fig.1.—Mean seasonal yield per harvest of grass cultivars in experiment 2.

consistently outyielded the four other cultivars. In experiment 2 the initial yield advantage was with Petrie green panic and Gatton panic but these then trailed other cultivars for the rest of the study period. The value of Bambatsi panic and Burnett panic where some flooding occurred in experiment 2 is noticeable. Because of flooding, yields from experiment 2 beyond the spring of the third year must be treated with caution.

Mean seasonal grass yields of experiment 2 are presented in Figure 1. These have been assembled on the basis of:—

Spring = Nov. 3, 1964 + Nov. 1, 1966

Summer = Mar. 2, 1964 + Feb. 15, 1965 + Feb. 14, 1966.

Autumn = May 26, 1965 + May 30, 1966 + May 25, 1967.

The establishment harvest (Mar. 11, 1963) has been excluded.

The markedly better summer yields of Bambatsi panic, Burnett panic, *Panicum coloratum* Q 4901 and *Digitaria smutsii* are most noticeable.

TABLE 4

EFFECTS OF GRASS CULTIVARS IN EXPERIMENT 1 ON NITROGEN PERCENTAGE AND CRUDE PROTEIN YIELD OF GRASS SEPARATES AT EACH BEFORE-GRAZING HARVEST

	Year 1	Year 2		Year 3		Year 4		Year 5			All Years
	5.ii.64*	21.i.65	19.v.65	10.ii.66	27.vi.66	20.x.66	13.ii.67	22.x.67	31.i.68	7.v.68	Mean†
NITROGEN CONTENT (%N) in Grass											
Gatton panic ..	1·38	1·12	1·38	1·11	1·78	1·56	1·19	1·64	0·62	0·95	0·99
Callide Rhodes	0·78	0·70	1·08	1·21	1·33	1·83	1·14	1·92	0·73	0·98	0·98
Pioneer Rhodes	0·68	0·92	1·17	1·09	1·21	1·52	1·07	1·72	0·86	0·90	0·97
Petrie green panic	1·08	1·12	1·23	1·00	1·64	1·48	1·05	1·51	0·61	0·93	0·96
Biloela buffel ..	0·87	0·85	1·02	0·85	0·84	1·23	0·78	1·29	0·66	0·68	0·83
Molopo buffel ..	0·70	0·85	0·92	0·79	0·83	1·01	0·68	1·16	0·59	0·63	0·74
L.S.D. 5%	..	..	..	0·24	0·22	0·14	0·12	0·09	0·07	..	..
L.S.D. 1%	..	..	..	0·32	0·29	0·18	0·16	0·12	0·10	..	..
CRUDE PROTEIN YIELD (lb/ac) in Grass											Total
Biloela buffel ..	188	71	102	171	37	23	98	62	135	67	954
Molopo buffel ..	175	86	76	145	43	38	80	50	121	98	912
Gatton panic ..	189	35	58	157	28	14	67	35	89	32	704
Callide Rhodes	155	46	57	77	14	4	85	10	98	103	649
Petrie green panic	153	49	62	102	28	15	71	27	79	59	645
Pioneer Rhodes	167*	63	41	65	11	17	83	8	93	90	638
L.S.D. 5%	..	..	..	..	..	..	..	..	..	..	..
L.S.D. 1%	..	..	..	..	..	..	..	..	..	..	..

* 5.ii.64 harvest, total dry matter analysed.

† 5.ii.64 harvest omitted from calculations of mean % N.

(b) Grass Forage Quality

The nitrogen content and crude protein yields of the grass separate at each harvest of experiments 1 and 2 are shown in Tables 4 and 5.

TABLE 5

EFFECT OF GRASS CULTIVARS IN EXPERIMENT 2 ON MEAN NITROGEN PERCENTAGE AND CRUDE PROTEIN YIELD OF GRASS SEPARATES AT EACH HARVEST

Year	1	2	3			4		5		Mean
Harvest Date	11.iii.63	2.iii.64	3.xi.64	15.ii.65	26.v.65	14.ii.66	30.v.66	1.xi.66	25.v.67	
NITROGEN CONTENT (%N) in Grass										
Gatton panic	1·66	0·80	1·15	0·64	1·05	0·91	1·30	1·16	0·85	1·21
Petrie green panic ..	1·68	0·69	1·15	0·67	1·16	0·83	1·45	1·16	0·82	1·11
Panicum coloratum Q4901	1·68	0·91	1·39	0·66	1·55	0·96	1·30	1·12	0·48	0·95
Nunbank buffel ..	1·46	0·67	1·24	0·77	1·09	0·77	1·01	1·02	0·47	0·94
Bambatsi panic ..	1·62	0·90	1·49	0·67	1·60	0·94	0·96	1·01	0·49	0·90
Biloela buffel	1·46	0·72	1·31	0·80	0·98	0·80	1·07	0·93	0·44	0·90
Lawes buffel	1·31	0·62	0·96	0·64	0·92	0·82	1·10	0·87	0·48	0·90
Tarewinnabar buffel ..	1·36	1·01	0·94	0·78	0·77	0·73	0·96	0·89	0·53	0·88
Molopo buffel	1·41	0·67	0·93	0·77	1·15	0·69	0·96	0·85	0·47	0·84
Burnett panic	1·58	0·64	1·34	0·62	1·44	0·90	1·13	0·94	0·47	0·82
Digitaria smutsii ..	2·37	0·64	1·33	0·56	1·43	0·92	1·45	1·08	0·63	0·81
L.S.D. 5%	..	..	..	..	..	0·11	0·22	0·12	0·09	..
L.S.D. 1%	..	..	..	..	..	0·14	0·30	0·17	0·12	..
CRUDE PROTEIN YIELD (lb/ac) in Grass										Total
Burnett panic	140	208	126	225	58	202	50	59	54	1,125
Petrie green panic ..	481	138	41	94	81	100	44	25	36	1,044
Panicum coloratum Q4901	146	226	100	192	48	170	40	36	38	999
Tarewinnabar buffel ..	181	179	85	86	120	160	59	53	45	974
Bambatsi panic ..	31	187	106	210	70	226	36	61	42	973
Gatton panic	559	121	31	61	49	81	24	21	24	973
Molopo buffel	138	149	109	138	102	111	65	46	44	925
Biloela buffel	119	137	94	133	92	136	92	44	40	899
Nunbank buffel ..	177	124	82	70	141	143	53	38	35	872
Lawes buffel	231	113	99	41	98	88	68	35	32	811
Digitaria smutsii ..	2	158	99	131	56	199	25	51	22	743

NOTE: 11.iii.63 to 26.v.65 inclusive only one bulk sample for each cultivar analysed.

In Table 4 the lower quality, as indicated by nitrogen percentage, of Biloela and Molopo buffels throughout is readily apparent; despite this they have better crude protein yields because of their superior dry-matter yields. The higher quality feed provided by Petrie green panic and Gatton panic is again apparent in Table 5.

At two harvests of experiment 1, phosphorus content was also determined. The results are presented in Table 6. While there is some variability, Biloela and Molopo buffels again show rather lower levels of phosphorus but high phosphorus yield.

TABLE 6

EFFECTS OF GRASS CULTIVARS IN EXPERIMENT 1 ON GRASS PHOSPHORUS LEVELS BEFORE GRAZING AT TWO HARVESTS

Cultivar	10.ii.66	27.vi.66
% PHOSPHORUS MOISTURE-FREE		
Petrie green panic	0·516	0·914
Gatton panic ..	0·329	0·720
Callide Rhodes ..	0·460	0·565
Pioneer Rhodes ..	0·357	0·473
Molopo buffel ..	0·391	0·454
Biloela buffel ..	0·380	0·429
L.S.D. 5%	0·054	0·073
L.S.D. 1%	0·072	0·099
PHOSPHORUS YIELD (lb/ac)		
Biloela buffel ..	11·90	2·93
Molopo buffel ..	11·35	3·75
Petrie green panic	8·20	2·34
Gatton panic ..	8·12	1·64
Callide Rhodes ..	4·98	0·91
Pioneer Rhodes ..	3·45	0·76
L.S.D. 5%	2·96	0·83
L.S.D. 1%	3·99	1·12

(c) Utilization

When grazing of experiment 1 was moderate and of short duration, utilization of the various cultivars was assessed by carrying out a post-grazing harvest. Table 7 shows the differences recorded between the before and after grazing harvests.

The total utilization figures in Table 7 are not comparable with the totals of dry-matter yield in Table 2, as no post-grazing harvests were carried out where utilization was reasonably complete.

There is, however, much less variation between the quantities utilized than there is between the total dry-matter yields. The utilization percentages shown in Table 8 for total dry-matter and the grass component show the lower relative use of Pioneer Rhodes compared with Callide Rhodes, while Petrie green panic and Gatton panic were well grazed and except in one instance Molopo buffel was better, although not always significantly better, grazed than Biloela buffel.

(d) Frost Tolerance

During the severe 1963 winter, when both experiment 1 and experiment 2 were in their first season, it was apparent that Molopo buffel in experiment 1 and Molopo and Lawes buffels and Burnett and Bambatsi panics in experiment 2

were not completely frosted. The green plots of each could be readily identified from a distance, while all other lines were completely brown. Molopo and Lawes buffels were frosted in subsequent winters but Bambatsi and Burnett were never completely affected. Results of an attempt to measure the relative frost tolerances at the end of the 1963 winter in experiment 2 are shown in Table 9.

TABLE 7

EFFECTS OF GRASS CULTIVARS IN EXPERIMENT 1 ON ACTUAL UTILIZATION OF MAJOR COMPONENTS OF TOTAL YIELD

lb/ac ODM removed

Cultivar	25.ii.64	3.ii.65	1.vi.65	24.ii.66	20.iii.67	29.xi.67	3.vi.68	Total
TOTAL DRY-MATTER UTILIZATION								
Molopo buffel ..	2,115	1,047	1,457	423	−29	751	2,903	8,667
Gatton panic ..	1,243	562	1,108	1,401	1,229	822	1,906	8,271
Callide Rhodes ..	2,061	1,033	1,070	673	617	682	2,108	8,244
Biloela buffel ..	1,573	632	1,362	169	350	984	1,953	7,023
Petrie green panic ..	1,952	428	720	674	890	647	1,567	6,878
Pioneer Rhodes ..	1,492	268	577	424	547	623	2,372	6,303
L.S.D. 5%	..	..	..	880	..	..	..	..
L.S.D. 1%	..	..	..	1,183	..	..	..	..
GRASS UTILIZATION								
Molopo buffel ..	Not	1,131	1,223	1,469	206	474	2,393	6,896
Callide Rhodes ..	sepa-	839	762	690	987	74	1,624	4,976
Biloela buffel ..	rated	710	1,250	633	625	506	1,221	4,945
Petrie green panic ..	..	388	643	747	798	271	946	3,793
Gatton panic ..	..	135	601	1,080	675	303	486	3,280
Pioneer Rhodes ..	..	130	338	−24·1	551	55	1,369	2,419
L.S.D. 5%	..	..	..	..	752	..	..	..
L.S.D. 1%	..	..	..	..	1,010	..	..	..
SOWN LEGUME UTILIZATION								
Gatton panic ..	Not	340	322	144	116	503	743	2,168
Pioneer Rhodes ..	sepa-	147	216	301	106	613	373	1,756
Callide Rhodes ..	rated	173	232	465	18	666	177	1,731
Biloela buffel ..	..	208	214	140	25	544	446	1,572
Molopo buffel ..	..	149	283	181	68	373	422	1,476
Petrie green panic ..	..	44	136	156	88	385	312	1,121
L.S.D. 5%	..	..	..	..	200	..	..	..
L.S.D. 1%	..	..	..	..	269	..	..	..

TABLE 8

EFFECTS OF GRASS CULTIVARS IN EXPERIMENT 1 ON THE PERCENTAGE UTILIZATION OF TOTAL AND GRASS YIELDS AT INDIVIDUAL GRAZINGS

Cultivar		25.ii.64	3.ii.65	1.vi.65	24.ii.66	20.iii.67	29.xi.67	3.vi.68
TOTAL DRY-MATTER UTILIZATION								
Pioneer Rhodes		40	18	57	16	32	52	87
Callide Rhodes		65	67	81	21	37	63	94
Biloela buffel		47	34	69	5	15	61	76
Molopo buffel		53	50	81	11	−1·3	58	84
Petrie green panic		84	40	66	27	58	61	94
Gatton panic		50	40	79	22	59	72	85
L.S.D.	5%	20	..	..	37	..	16	12
L.S.D.	1%	26	..	..	50	..	22	16
GRASS UTILIZATION								
Pioneer Rhodes		..	12	61	−24·5	44	56	82
Callide Rhodes		..	79	90	53	81	91	93
Biloela buffel		..	53	79	22	31	70	72
Molopo buffel		..	69	93	48	2	75	94
Petrie green panic		..	55	82	42	66	90	95
Gatton panic		..	27	88	38	74	90	79
L.S.D.	5%	..	..	10	37	24	21	17
L.S.D.	1%	..	..	13	50	33	29	23

TABLE 9

EFFECT OF COLD DURING THE FIRST WINTER ON SOME GRASSES IN EXPERIMENT 2 EXPRESSED AS PERCENTAGE GREEN AND DRY LEAF AND CRUDE PROTEIN LEVELS

Sampled 14.viii.63

Cultivar	% Green Leaf	% Dry Leaf	Crude Protein %	
			Green Leaf	Dry Leaf
Bambatsi panic	46·0	54·0	14·2	9·4
Burnett panic	35·8	64·2	14·0	9·0
Lawes buffel	21·4	78·6	12·1	7·8
Molopo buffel	19·7	80·3	16·3	10·8
Petrie green panic	16·9	83·1	16·9	8·7
Gatton panic	13·6	86·4	18·7	9·0
Biloela buffel	8·6	91·4	18·6	9·5

Measurements were made 2 weeks after the last frost, during which period rain fell. Some new growth had been produced, particularly by Petrie green panic and Gatton panic. The superior percentage green leaf of Bambatsi and Burnett panics, however, was still noticeable.

In 1966, ten days and 0·49 in. of rain after the last frost, two plots of each grass cultivar in experiment 3 were harvested. Results recorded are shown in Table 10.

TABLE 10

EFFECT OF GRASS CULTIVAR IN EXPERIMENT 3 ON THE QUANTITY AND QUALITY OF STANDOVER FORAGE IN EARLY SPRING 1966
Harvested 6.ix.66

Grass	Oven-dry Yield (lb/ac)	Protein (%)	Protein Yield (lb/ac)	Moisture-Free Phosphorus (%)
Molopo buffel	3,890	8·4	322·5	0·27
Petrie green panic	4,761	5·3	254·1	0·20
Bambatsi panic	3,208	6·9	223·2	0·25
Biloela buffel	3,460	3·8	132·0	0·21

The superior quality of Molopo buffel and Bambatsi panic is noticeable. Petrie green panic was the only grass making active growth when harvested.

Over the following winter cumulative yields were followed from six plots of each grass. The mean results are presented in Table 11. The superior performance

TABLE 11

WINTER GROWTH AND FROST REACTION OF GRASS CULTIVARS IN EXPERIMENT 3 OVER 1967 WINTER
Cumulative yields from May (lb/ac ODM)

Cultivar	TOTAL DRY MATTER			GREEN GRASS			DEAD GRASS	
	28.vi.67	2.viii.67	5.ix.67	28.vi.67	2.viii.67	5.ix.67	2.viii.67	5.ix.67
Molopo buffel ..	464	1,092	1,304	464	983	1,142	109	162
Biloela buffel ..	318	823	857	318	407	320	415	537
Petrie green panic ..	350	619	597	350	437	340	181	257
Bambatsi panic ..	98	433	480	98	319	270	114	190
L.S.D. 5%	94	208	199	94	183	215	62	85
L.S.D. 1%	128	284	271	128	249	293	104	142

of Molopo buffel on this occasion in terms of both growth and frost tolerance is noticeable. Bambatsi panic, while not frosted heavily, made very little growth.

(e) Miscellaneous Observations

Within this section data are presented from the three experiments which describe further characteristics of the cultivars.

TABLE 12

PLANT POPULATIONS IN EXPERIMENT 2 TWELVE WEEKS AFTER PLANTING

Plants/sq lk

Treatment	Plants/sq lk
Gatton panic	2·07
Burnett panic	1·88
Petrie green panic	1·73
Panicum coloratum Q4901 ..	1·55
Lawes buffel	0·91
Molopo buffel	0·84
Digitaria smutsii	0·69
Bambatsi panic	0·61
Tarewinnabar buffel	0·60
Nunbank buffel	0·59
Biloela buffel	0·37
L.S.D. 5%	0·49
L.S.D. 1%	0·65

The only establishment assessment made was for experiment 2, where on March 22, 1963, the stand densities shown in Table 12 were recorded. With the exception of Bambatsi panic, which had an inadequately cleaned seed sample, the *Panicum* cultivars gave higher establishment densities than the buffel grasses from the planting of 3 lb/ac.

In experiment 1, lucerne invasion of the original siratro plots occurred to a limited extent in the winter of 1964 and to a greater extent in 1966 and 1967. From June 1966 onwards the effects of this in terms of lucerne yield from these

TABLE 13

EFFECT OF GRASS CULTIVAR IN EXPERIMENT 1 ON LUCERNE INVASION OF SIRATRO PLOTS

lb/ac OD yields of invading lucerne

Cultivar	27.vi.66	20.x.66	13.ii.67	22.xi.67	31.i.68	7.v.68	Total
Callide Rhodes	191	1,055	238	870	607	181	3,142
Pioneer Rhodes	90	739	216	802	800	373	3,021
Gatton panic	35	551	220	523	760	515	2,604
Biloela buffel	42	683	124	469	468	292	2,082
Molopo buffel	42	581	241	428	171	582	2,045
Petrie green panic	48	454	49	282	358	376	1,567
L.S.D. 5%	89	509	416	567	735	585	..
L.S.D. 1%	123	704	575	784	1,016	808	..

plots was recorded. Data are presented in Table 13. Initial invasion was most rapid in the Rhodes grass plots, especially Callide Rhodes, but subsequently all grasses were invaded to approximately the same extent.

Experiment 2 was partially flooded by heavy rains commencing on December 26, 1964, at which stage the grasses were well grown, but by the harvest on February 15, 1965, a high proportion of the growth on many plots was dead. Table 14 shows the percentage of other species and inert recorded for each cultivar at this harvest as an indication of the reaction of the various cultivars to wet conditions. Too great an emphasis should not be placed on these data, as a small

TABLE 14

PERCENTAGE OF TOTAL DRY MATTER PLACED IN THE INERT AND OTHER SPECIES CATEGORY AT HARVEST OF EXPERIMENT 2 ON 15.ii.65 SIX WEEKS AFTER INITIAL FLOODING

Cultivar	Inert and other species (% dry matter)
Lawes buffel	74·1
Nunbank buffel	67·6
Tarewinnabar buffel	57·8
Biloela buffel	51·5
Molopo buffel	30·3
Digitaria smutsii	26·5
Petrie green panic	18·0
Gatton panic	18·3
Panicum coloratum Q4901 ..	7·6
Bambatsi panic	2·5
Burnett panic	1·8

proportion of plots escaped the shallow (2–3 in.) flooding. The buffel grasses all showed high percentages of inert material, almost entirely dead sown grass, while the three *P. coloratum* cultivars were virtually unaffected.

IV. DISCUSSION

Due to the flooding which occurred midway through experiment 2 and re-occurred in 1966, the results of this experiment must be regarded as suspect, especially with regard to dry-matter yields. It had been hoped in particular to make close comparisons within three groups of cultivars, the two members of each group being morphologically very similar. The flooding frustrated comparisons between Biloela and Nunbank buffels on the one hand and Lawes and Molopo buffels on the other.

The uneven initial stands affect the comparison between Burnett and Bambatsi panics over the first 2 years. Subsequently these stands appeared to even up

and there was little further difference in yield between the two cultivars. Uneven initial stand also prevents close comparison of the buffel grasses, especially Biloela and Molopo, in the first 2 years.

Overall, the major feature to be documented by these experiments is the higher yields from buffel grasses than from the *P. maximum* cultivars under all conditions, except in the establishment phase. Gatton panic and Petrie green panic, however, provided higher quality feed.

Also apparent is the high potential of the cultivars of *Panicum coloratum* to make rapid midsummer growth, but their level of winter growth, despite almost complete frost tolerance when they enter the winter in an immature vegetative state, is very low. The latter is important in utilizing their frost tolerance, as mature nursery rows on every occasion were completely frosted over winters. In the grazed experiments, however, despite very cold July weather during 1963 and 1965 Bambatsi and Burnett panics were never completely frosted. Any dead leaf present at the end of the winter could be ascribed to lack of moisture rather than to frost. The common *Panicum coloratum* line Q4901, on the other hand, did not display the same frost tolerance, while *Digitaria smutsii,* which grew well in summer, was completely frosted each winter.

The two *Panicum maximum* cultivars established extremely rapidly and gave very high initial yields in experiment 2 but then faded badly. Rapid utilization of available soil nitrogen is suggested as being responsible. This was accentuated by low levels of lucerne, which was suppressed by the rapid initial growth of these two cultivars. The *Panicum coloratum* and *Digitaria smutsii* cultivars, on the other hand, were rather slow to establish and gave poor initial yields.

In experiment 1, Gatton panic established poorly. It gradually built up to adequate stands in the higher fertility lucerne plots but not in the plots originally sown with siratro, these being virtually grass-alone treatments initially.

The value of Molopo buffel reported by Cameron and Courtice (1965) was confirmed in all three experiments. Its frost tolerance was erratically expressed but this is thought to have been due to variations in available soil nitrogen. Experiment 3 in 1967 was the only occasion on which frost tolerance was recorded in an old stand. On this occasion only 1·61 in. of rain were recorded for the three autumn months. These were followed by a wet winter.

It is noticeable, however, that its autumn and spring yields in experiment 1 were generally superior to those of Biloela buffel but its midsummer yields were generally inferior. It has exhibited a more even year-round growth rate. It is known to have a high nitrogen requirement for seed production (Cameron and Mullaly 1969*b*) and it seems likely that this feature could also control its expression of frost tolerance and winter growth.

Callide Rhodes reacted no more adversely to the dry conditions of 1965 than did Pioneer Rhodes but it was much more completely utilized throughout experiment 1, while Petrie green panic and Gatton panic were also better grazed than the buffels, which in turn were better grazed than Pioneer Rhodes.

It has been possible to document the major agronomic features of the various cultivars. Cameron (1968), however, has pointed out that determination of the relative importance of these features will remain very much a matter of personal judgment until more clearly defined by grazing animals. This has yet to be carried out in many instances.

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