

**Adaptation of Grass-Legume Mixtures
for Southeastern Virginia**

Research Report No. 18

May, 1958

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Blacksburg, Virginia**

ADAPTATION OF GRASS-LEGUME MIXTURES FOR SOUTHEASTERN VIRGINIA¹

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Perennial grasses and legumes used for pasture, silage, and hay vary in their adaptation to temperature, moisture, light and other factors that affect growth. In general, the cool-season forage plants of northern origin are more productive during the spring season when compared with summer and fall herbage growth. On the other hand, forage plants of southern origin require comparatively high temperatures and are especially productive during the warmer summer months.

Forage plants of both northern and southern origin are used in southeastern Virginia. The data in this report give information on the yields, persistence of stands of different species as shown by botanical composition, and chemical composition of forage species of mixed seedlings of grasses and legumes grown at the Tidewater Research Station near Holland.

METHODS AND MATERIALS

An Othello loam located on the Tidewater Research Station at Holland, Virginia was selected for this investigation. The area had been cropped for several years to corn and pasture and was medium in acidity but relatively high in both available phosphorus and potash, according to soil quick tests. However, to insure that fertility was adequate, sufficient lime to obtain a pH level between 6.0 and 6.5, and 1000 pounds per acre of a 2-12-12 fertilizer were broadcast and disked in prior to the establishment of the forage mixtures. Also, borated fertilizer was topdressed at a rate of 500 pounds per acre in February and June during the study.

The forage mixtures and species (table 1) were seeded in September, 1953, except lespedeza and Dallis grass which were sown the following March. The experimental design was a complete randomized block with 3 replications; the plots were 10 x 20 feet in size.

The herbage was harvested 5 times, usually in April, May, June, August and September during 1953 and 1954, and 4 times during 1955 and 1956. Yields were obtained by cutting a swath 30 inches wide lengthwise through the center of each plot, after removing a 15-inch border from each end of the plots. An aliquot weighing approximately 2 pounds of the green herbage was taken and dried at 70° C to calculate dry matter yields.

1. This study was supported in part by a grant from the American Bank and Trust Company, Suffolk, Virginia.
2. Associate Professor and Professor of Agronomy, Holland and Blacksburg, Virginia, respectively, and both with the Virginia Agricultural Experiment Station, Virginia Polytechnic Institute.

Estimates of the botanical composition of the forage were made at each cutting. A herbage subsample of the second and fourth harvest each year from each plot was separated by hand into botanical species for more accurate data. Botanical composition of the other cuttings was estimated on a percentage basis by observation before the forage was cut.

The species separates obtained from the second and fourth cuttings were ground and analyzed for contents of calcium, potassium, magnesium, phosphorus, and nitrogen.

RESULTS AND DISCUSSION

The average yields of the grass-legume mixtures for each of the years 1953 to 1956, inclusive, are presented in table 2. These yields include weeds as well as desirable forage species. Although there appear to be rather large differences in the total forage production by the various mixtures, an analysis of variance failed to indicate any differences that were significant (0.05 level). On the other hand, statistical analysis of the yield data exclusive of weeds revealed that the mixture orchard grass-ladino clover-alfalfa produced significantly more forage than the other mixtures, except the Kentucky 31 fescue-orchard grass-ladino clover mixture. Nevertheless, the yields of these two mixtures differed by more than 1000 pounds of dry matter per acre annually. The data in table 2 indicate that the mixture including alfalfa produced more forage than any other mixture during each of the 4 years, except 1954, when the growth of Dallis grass was excellent during a very dry period late in the summer. During the first 3 years of the test, and particularly in 1954 and 1955, the mixture Granger trefoil-orchard grass yielded well, especially in the later cuttings.

Perhaps a better conception of production by the various forages included in this study may be obtained from the data presented in table 3, which gives the average estimated yields of each species. As expected, most of the species produced considerably more forage in the early spring cuttings than later in the season. On the other hand, alfalfa, Granger trefoil, and Dallis grass yielded quite well during the hot, dry part of the summer. Also, Reed canary grass appeared to produce well under dry conditions, but it was difficult to obtain good stands of this grass, which may have limited yields. However, stands thickened toward the end of the test and in 1956 the yield of forage by Reed canary grass was second only to fescue as regards the grasses, except for the orchard grass-Lespedeza mixture where the orchard grass had little or no competition.

In attempting to compound legume-grass mixtures from these data, it should be noted (table 3) that fescue tended to persist longer than orchard grass and by 1956 appeared to be crowding it out where the 2 grasses were seeded together. Nevertheless, forage production by orchard grass for the first 3 years was apparently superior to fescue and an explanation for its production drop in 1956 may well be attributed to orchard grass diseases.

Dallis grass stands and growth were poor in 1953, but it produced well during the other years. Dallis grass produced most of its growth in July, August, and September when most of the cool season pasture grasses grew slowly and made low yields. Dallis grass pastures may have a very useful place for summer feed production in this area, but its growth in spring and fall is poor because of low temperatures.

In regard to the legumes, ladino clover gave good yields, but it produced poorly during the warm part of the growing season, especially during dry periods which are common during July and August in southeastern Virginia. The forage production potential of Louisiana white clover appeared to be equivalent to that of ladino clover and its seasonal growth pattern was similar. Granger trefoil produced very well in the July-August period, but stands of this legume became thin by 1956 and yields were markedly lower.

The results of this study indicated that the use of alfalfa in mixtures may increase yields, especially during the warmer and drier period of the growing season. Although the soil on which the forages were grown was rather poorly drained, stands of alfalfa persisted during the 4 years. This mixture experiment indicates that orchard grass, Kentucky 31 fescue, Dallis grass, white clover, alfalfa, and ladino clover are the best adapted species. Other research and farm experience in this region points out that red clover and lespedeza are also well adapted. Granger and other varieties of birds-foot trefoil are known to be short-lived under Virginia conditions because of their susceptibility to diseases.

Since not only the total amount of precipitation, but also its distribution is so vitally important to forage production, the rainfall received at Holland, Virginia during the period March to October, inclusive, of each year of the study is given by weeks in table 4. In general, during this 4-year study, precipitation in June and July was considerably under normal. Therefore, lack of adequate moisture undoubtedly depressed the yields of the forages considerably. The amount of rainfall received during August of each year was equivalent to or in excess of the normal precipitation, but most of those rains were high intensity storms resulting in considerable run-off. This reduced moisture availability, and production of most of the forages remained low during the fall season. The growth of many of the species probably was limited by rather high temperatures, since an average of approximately 40 days in which maximum temperatures of 90° F or above were recorded for the period June, July, and August of each year and nearly one-half of these days occurred during July.

The mineral composition of the second and fourth cuttings was determined each year and the average contents of several nutrient elements and protein are given in table 5. These data indicate that the percentages of the 5 constituents were adequate for high quality herbage in the case of all 12 forage mixtures included in this study.

CONCLUSIONS

Thirteen species were included in 12 different forage mixtures in an attempt to evaluate their adaptability and seasonal production patterns when grown under southeastern Virginia conditions. Certain results warrant emphasis:

1). Average yields of forage, exclusive of weeds, obtained from the mixture orchard grass-ladino clover-alfalfa exceeded that from all other mixtures by approximately 1100 pounds per acre, annually. This mixture produced significantly more forage than 10 out of the 12 mixtures included in the study.

2). Alfalfa, Granger trefoil and Dallis grass produced more than the other species tested during the warm and dry summer conditions, but Granger trefoil was short-lived.

3). Kentucky 31 fescue tended to live longer than orchard grass; however, orchard grass tended to produce more forage than Kentucky 31 fescue during the 4 years.

4). The contents of calcium, magnesium, potassium, phosphorus, and protein in the herbage from all species indicates that the forage was of a high quality.

5). The results indicate that 2 or more adapted species such as orchard grass, Kentucky 31 fescue, alfalfa, ladino clover and Louisiana white clover may be used in making up grass-legume mixtures for southeastern Virginia. Dallis grass which was difficult and slow to establish might be used where summer production is desired.

Table 1. Forage mixture and species seeding rates, Holland, Virginia.

Forage Mixture	Seeding rate Lbs./A.
A. Orchard grass - ladino clover	12 - 2
B. Kentucky 31 fescue - ladino clover	12 - 2
C. Kentucky 31 fescue - orchard grass - ladino clover	6 - 6 - 2
D. Orchard grass - ladino clover - alfalfa	6 - 1 - 12
E. Orchard grass - ladino clover - red clover	12 - 1 - 3
F. Dallis grass - Louisiana white clover - lespedeza	45 - 1 - 10
G. Orchard grass - lespedeza	6 - 20
H. Reed canary grass - ladino clover	15 - 2
I. Oklahoma brome grass - ladino clover	15 - 2
J. Orchard grass - Big trefoil	4 - 8
K. Orchard grass - Granger trefoil	4 - 12
L. Orchard grass - redbtop - ladino clover	6 - 3 - 2

Table 2. Average annual yields of dry herbage obtained from pasture forage mixtures, Holland, Virginia, 1953 - 1956.

Forage Mixtures	Pounds per acre dry hay				Average	:Statistical* :Significance
	1953	1954	1955	1956		
Orchard grass Ladino clover	7125 (6775)**	4895 (4745)	5020 (4730)	5215 (4360)	5565 (5150)	b
Ky. 31 fescue Ladino clover	7180 (6850)	4885 (4420)	4440 (3695)	5820 (5035)	5580 (5000)	b
Ky. 31 fescue Orchard grass Ladino clover	7485 (7230)	5880 (5745)	4905 (4895)	6200 (5920)	6120 (5950)	ab
Orchard grass Ladino clover Alfalfa	7870 (7685)	6770 (6660)	6895 (6800)	7070 (7070)	7150 (7055)	a
Orchard grass Ladino clover Red clover	7455 (7215)	5395 (5035)	4665 (4540)	5420 (4870)	5735 (5415)	b
Dallis grass Lespedeza# Ia. white clover	5075 (3675)	8785 (7815)	5340 (4255)	6365 (4155)	6390 (4975)	b
Orchard grass Lespedeza#	2655 (1855)	3860 (2630)	3975 (3150)	6780 (3740)	4320 (2845)	d
Reed canary grass Ladino clover	7250 (6440)	4735 (4275)	5315 (2975)	6355 (5150)	5915 (4710)	bc
Okla. brome grass Ladino clover	6695 (5940)	4365 (3650)	5135 (3200)	6225 (4125)	5605 (4230)	bcd
Big trefoil Orchard grass	2990 (2415)	3995 (2730)	4460 (3650)	6130 (3055)	4395 (2960)	d
Granger trefoil Orchard grass	5805 (5320)	6725 (6030)	6540 (6145)	6165 (2960)	6310 (5115)	b
Orchard grass Redtop Ladino clover	7110 (6895)	5080 (4820)	4915 (4590)	5840 (4965)	5735 (5320)	b

* Unlike letters denote significant yield differences at 0.05 level.

**Yields given in parentheses are exclusive of weeds.

Lespedeza stands were extremely poor.

Table 3. Average yields of dry herbage obtained from forage mixture species by cuttings and years, Holland, Virginia, 1953 - 1956.

Forage mixtures species	Yields per cutting					Yields, all cuttings				
	1st	2nd	3rd	4th	5th	1953	1954	1955	1956	Ave.
Orchard grass	890	555	355	410	210	1765	1625	4105	1765	2315
Ladino clover	1030	785	570	355	205	5010	3120	625	2595	2840
Ky. 3l fescue	820	480	280	395	170	1175	1370	2605	3075	2055
Ladino clover	1075	830	545	340	320	5675	3050	1090	1960	2945
Ky. 3l fescue	400	340	160	255	85	510	715	1205	2390	1205
Orchard grass	680	330	270	380	190	1115	1930	2675	1325	1760
Ladino clover	1155	825	570	320	220	5605	3100	1015	2205	2980
Orchard grass	765	460	280	475	210	1785	1705	2225	2625	2085
Ladino clover	845	455	400	170	155	2585	2355	575	2270	1945
Alfalfa	895	730	570	660	330	3315	2600	4000	2175	3020
Orchard grass	1040	715	360	500	310	2260	2325	3975	2520	2770
Ladino clover	855	610	490	280	210	3845	2615	565	2350	2345
Red clover	225	25	30	5	30	1110	95	0	0	300
Dallis grass	65	80	280	1395	870	365	4660	2830	1070	2230
Lespedeza	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
La. white clover	1140	775	650	105	150	3310	3155	1425	3085	2745
Orchard grass	835	650	390	765	430	1885	2630	3150	3740	2850
Lespedeza	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Reed canary grass *	285	400	290	460	130	295	760	1915	3040	1500
Ladino clover	1390	720	680	280	270	6145	3515	1060	2110	3210
Okla. brome grass *	535	250	105	250	50	830	540	1850	1430	1160
Ladino clover	1260	750	640	295	250	5110	3110	1350	2695	3065
Big trefoil	230	65	40	35	20	360	420	555	200	385
Orchard grass	830	585	385	595	370	2055	2310	3095	2855	2580
Granger trefoil	785	515	525	595	460	3375	3705	2825	710	2655
Orchard grass	820	530	385	585	280	1955	2325	3320	2250	2460
Orchard grass	890	455	320	430	200	980	1585	3865	2355	2195
Redtop	140	50	45	5	25	705	210	85	20	255
Ladino clover	1110	825	510	320	210	5210	3025	640	2590	2865

* Stands inferior.

Table 4. Rainfall* by weeks during the period March to October, inclusive, Holland, Virginia, 1953-56.

Date of week		1953		1954		1955		1956	
Month	Days	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly
March	1-7	1.31		1.22		2.06		0.04	
	8-14	0.57	2.52	1.42	3.80	0.21	3.56	0.70	3.35
	15-21	0.35	(-1.03)#	0.32	(+ 0.25)	1.21	(+0.01)	2.05	(-0.20)
	22-28	0.29		0.27		0.08		0.31	
April	29-4	0.17		1.03		0.00		0.25	
	5-11	0.71	3.26	0.42	2.39	0.10	3.21	1.51	4.60
	12-18	2.22	(-0.30)	0.74	(-1.17)	1.22	(-0.35)	2.52	(+1.04)
	19-25	0.06		0.00		1.68		0.24	
May	26-2	1.75		0.77		0.21		0.39	
	3-9	0.48	4.64	1.78	5.93	0.08	2.23	1.56	2.93
	10-16	0.13	(+1.50)	1.98	(+2.79)	0.50	(-0.91)	0.00	(-0.21)
	17-23	2.32		1.76		1.04		0.89	
June	24-30	0.06		0.41		0.40		0.42	
	31-6	0.20		0.00		0.32		1.83	
	7-13	1.40	3.54	0.06	1.04	3.22	5.31	0.00	1.93
	14-20	0.76	(-1.15)	0.98	(-3.65)	1.13	(-0.62)	0.09	(-2.76)
July	21-27	0.12		0.00		0.85		0.00	
	28-4	1.06		0.31		0.30		0.01	
	5-11	0.39	1.32	1.38	4.34	2.00	3.55	1.60	5.90
	12-18	0.00	(-5.83)	0.90	(-2.81)	0.85	(-3.60)	0.03	(-1.25)
Aug.	19-25	0.93		1.75		0.32		1.42	
	26-1	1.05		0.00		0.10		2.85	
	2-8	1.13	10.61	2.19	6.01	0.00	13.42	1.92	6.15
	9-15	5.58	(+4.57)	0.16	(-0.03)	6.56	(+7.38)	1.47	(+0.11)
Sept.	16-22	2.85		0.10		2.80		1.35	
	23-29	0.00		3.21		4.04		1.39	
	30-5	0.16		0.35		4.28		0.70	
	6-12	0.76	4.76	1.22	1.58	0.37	10.34	0.67	5.70
Oct.	13-19	0.05	(+0.33)	0.07	(-2.85)	1.56	(+5.91)	0.00	(+1.27)
	20-26	0.59		0.04		4.13		0.37	
	27-3	3.20		0.25		0.49		3.98	
	4-10	0.46	0.70	0.16	2.85	0.18	2.78	0.57	7.23
34.89**	11-17	0.00	(-1.63)	1.89	(+0.52)	-1.16	(+0.45)	0.23	(+4.90)
	18-24	0.00		0.02		0.07		4.65	
	25-31	0.24		0.78		0.88		1.78	
Total		31.35		27.94		44.40		37.79	
Departure		-3.54		-6.95		+9.51		+2.90	

* Rainfall data is recorded in inches.

** Normal rainfall as per 20 year average.

Departures from normal given in parentheses under amount received monthly.

Table 5. Average chemical composition of forage species at 2 cutting dates, Holland, Virginia, 1953-56.

Forage Mixtures	Percentage of following constituents in second and fourth cuttings (oven dry basis).									
	Protein		Phosphorus		Potassium		Calcium		Magnesium	
	2nd	4th	2nd	4th	2nd	4th	2nd	4th	2nd	4th
Orchard grass	22.3	21.5	0.48	0.39	4.13	3.57	0.31	0.37	0.30	0.28
Ladino clover	27.4	23.4	0.38	0.40	3.03	2.85	1.17	0.90	0.38	0.37
Ky. 31 fescue	17.6	20.2	0.49	0.48	3.53	3.45	0.37	0.38	0.32	0.31
Ladino clover	27.8	24.8	0.36	0.39	2.98	3.02	1.14	0.93	0.43	0.43
Ky. 31 fescue	17.8	21.4	0.53	0.47	3.78	3.37	0.36	0.41	0.36	0.36
Orchard grass	17.9	21.0	0.50	0.47	3.86	3.63	0.34	0.36	0.31	0.30
Ladino clover	26.2	25.2	0.37	0.43	2.69	2.65	1.17	0.93	0.41	0.39
Orchard grass	16.9	21.6	0.47	0.41	4.01	3.70	0.31	0.38	0.28	0.28
Ladino clover	28.7	24.9	0.40	0.38	3.32	3.00	1.13	0.92	0.38	0.36
Alfalfa	23.2	21.2	0.40	0.32	2.82	2.14	0.93	0.86	0.30	0.27
Orchard grass	16.1	21.5	0.49	0.43	3.99	3.48	0.33	0.36	0.30	0.29
Ladino clover	28.6	25.2	0.37	0.42	2.09	2.82	1.11	0.95	0.40	0.39
Red clover*	22.8	22.0	0.36	0.34	3.77	3.07	1.13	1.00	0.19	0.36
Dallis grass	20.9	15.0	0.36	0.34	3.25	2.95	0.34	0.29	0.25	0.19
Lespedeza	-	-	-	-	-	-	-	-	-	-
La. white clover	24.2	23.3	0.34	0.41	2.80	2.98	1.07	0.94	0.40	0.39
Orchard grass	18.1	18.4	0.52	0.54	3.49	3.44	0.34	0.33	0.29	0.27
Lespedeza	18.0	22.6	0.62	0.40	4.59	1.74	2.18	0.82	0.60	0.29
Reed canary grass	19.7	23.0	0.42	0.45	3.86	3.08	0.29	0.32	0.25	0.23
Ladino clover	28.8	24.6	0.38	0.41	3.20	3.12	1.06	0.91	0.37	0.35
Okla. brome grass	18.0	21.5	0.55	0.41	4.14	3.49	0.37	0.40	0.27	0.25
Ladino clover	27.5	24.1	0.45	0.40	3.46	3.06	3.06	0.90	0.38	0.37
Big trefoil	24.6	18.8	0.37	0.35	2.67	2.42	0.79	0.86	0.33	0.32
Orchard grass	13.9	17.1	0.48	0.52	3.40	3.17	0.32	0.30	0.26	0.24
Granger trefoil	23.4	19.2	0.40	0.34	3.18	2.62	0.85	0.85	0.34	0.33
Orchard grass	15.6	18.5	0.49	0.53	3.80	3.52	0.31	0.33	0.27	0.26
Orchard grass	18.4	21.9	0.50	0.43	4.13	3.70	0.31	0.37	0.30	0.29
Redtop*	21.5	23.2	0.44	0.38	4.10	3.07	0.46	0.34	0.30	0.20
Ladino clover	26.1	25.3	0.39	0.42	3.18	3.21	1.10	0.93	0.35	0.33

* Produced forage in 1953 season principally.