THE JOURNAL OF AGRICULTURE
OF THE UNIVERSITY OF PUERTO RICO

Issued quarterly by the Agricultural Experiment Station of the University of Puerto Rico, Mayagüez Campus, for the publication of articles and research notes by staff members or others, dealing with scientific agriculture in Puerto Rico and elsewhere in the Caribbean Basin and Latin America.

Vol. LXVIII APRIL 1984 No. 2

Evaluation of Eight Alfalfa Cultivars in a Cumulic Haplustolls of Southern Puerto Rico[1]

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ABSTRACT

Herbage and crude protein yields of 8 non-hardy alfalfa (*Medicago sativa*) cultivars under irrigation were evaluated at the Fortuna Agricultural Research and Development Center during 1980-1981. First year yields were excellent and ranged from 26,453 to 32,660 kg/ha in 343 days. The best performance (yield and persistence) was obtained with Hayden PX-1, Florida 66, Mesa Sirsa, and UC-163. Yields were highest during the months of April, May, and June, and lowest during August. In 1981, yields were lower and ranged from 13,060 to 19,534 kg/ha in 218 days. The cultivars with the highest forage and crude protein yields during the 10 cuttings in 1980, were also highest during the 7 cuttings in 1981. After 17 cuttings, the persistence of Mesa Sirsa, Florida 66, Tanhuato, Hayden PX-1, and UC-163 was 87, 85, 77, 76, and 65%, respectively. Mean crude protein, phosphorus, potassium, calcium, and magnesium contents for the 1980 cuttings were 21.5, 0.37, 3.44, 1.47, and 0.29%, respectively; for the 1981 cuttings, mean crude protein, phosphorus, and potassium contents were 23.2, 0.35, and 3.11%, respectively.

INTRODUCTION

Previous research (9) with 18 alfalfa (*Medicago sativa*) cultivars demonstrated that this crop shows promise for haymaking in the southern coast of Puerto Rico, with supplemental overhead irrigation. Among the most promising cultivars were Venezuela, Florida 66, Mesa Sirsa, and Moapa with total dry forage (DF) yields, respectively, of 11675, 11231, 10277, 9454 kg/ha during an 8-month growing period. Many of the cultivars produced good yields up to six cuttings, but thereafter their yields decreased dramatically. The stand persistence was poor because of inadequate surface and internal soil drainage and progressive infestation of *Phytophthora megasperma* in the stands of most of the cultivars after the 6th cutting (4, 9).

The present study was conducted to determine the production potential and persistence of several new alfalfa cultivars in a friable soil of the San Antón series (Mollisol), employing a high input of potassium.

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MATERIALS AND METHODS

Eight non-hardy alfalfa cultivars were planted January 22, 1980 at the Fortuna Agricultural Research and Development Center. Mean annual rainfall and air temperature at this site during the previous 10 years were 905 mm and 26° C, respectively. The top 20-cm layer of a San Antón soil at the experimental site, had a pH of 7.3 and contained 20 p/m phosphorus (P) and 556 p/m potassium (K).

Table 1 shows the cultivars and their origins. Tanhuato seed (open-pollinated) was collected in the humid mountainous region of Corozal. UC-164 consisted of open-pollinated material from Venezuela, UC-163 contained 25% of UC-164 plus a combination of four seed lots from the Dominican Republic. The experimental layout was a randomized complete block design with four replicates.

Individual plots were 549 cm long × 244 cm wide and included 8 plant rows. A 91-cm alley was left between replications. Plots were hand-sown at the rate of 13.4 kg/ha. Alfalfa seeds were inoculated with the proper

TABLE 1.—*Identification of alfalfa cultivars*

Cultivar[1]	Source
Az-Hayden-PX-1	Plant Sciences Department, University of Arizona, Tuczon, Ariz. 85721
Florida 66	Agronomy Department, University of Florida, Gainesville, Fla. 32611
Mesa-Sirsa	Plant Sciences Department, University of Arizona, Tucson, Ariz. 85721
Tanhuato	Corozal Agricultural Experiment Substation, University of Puerto Rico, Corozal, P. R. 00643
Moapa	FAO—United Nations Development Program, Santo Domingo, Dom. Rep.
UC-163	Agric. Sciences Division, Imperial Valley Field Station, University of California, El Centro, Calif. 92243
UC-164	do.
UC-176 E	do.

[1] This material was introduced through the S-9 (H-94) research project.

Rhizobium by means of the Pelinoc method (2) immediately before hand planting. The preemergence herbicide trifluralin (1) at the rate of 1.4 kg/ha (active ingredient) was incorporated into the soil 24 h prior to planting. Overhead irrigations were applied daily after planting to insure a uniform germination. Thereafter, overhead irrigations were applied 3 to 5 times per month throughout the experimental period (tables 2 and 3).

The experimental site was topdressed with 224 kg/ha P, 672 kg/ha K, and 6 kg/ha borax annually. In 1980, the plots were fertilized March 20, June 20, and September 22; in 1981, January 22 and April 24. Cuttings were at a 4- to 5-week interval. The plants were cut at a height of 5 cm above the soil surface in nearly full-bloom stage. All the green forage

(GF) was weighed and samples collected, dried at 60° C, and ground in a Wiley mill[3] to pass through a 1-mm screen.

Insects were controlled when necessary, with Diazinon AG-500 at a concentration of 0.125% in the final solution.

From January 22 to December 18, 1980, and from the latter date to August 6, 1981, rainfall totalled 500 and 300 mm, while supplemental irrigation totalled 457 and 343 mm, respectively (tables 2 and 3).

Dry matter (DM) content was determined in all samples. For each of the 10 cuttings in 1980, samples were composited by accessions over replications, and each sample was subjected to sulfuric acid digestion (6), prior to N, P, and K determinations with a Technicon auto analyzer and to Ca and Mg determinations by flame photometry (3). Crude protein (CP) was calculated as N × 6.25. The 1981 samples (7 cuttings) were composited in a similar way, but were analyzed for N, P, and K.

Data for GF, DF, and CP yields and for DM content were subjected to analyses of variance and Duncan's multiple range test (8).

The data were grouped for analyses as follows: from January 22 to December 18, 1980 (10 cuttings); from November 20, 1980 to March 18, 1981 (4 cuttings); and from December 19, 1980 to August 6, 1981 (7 cuttings).

RESULTS AND DISCUSSION

Table 2 shows DF yields at each of the 10 cuttings and total rainfall during the corresponding periods in 1980. Cultivar Hayden PX-1 yielded significantly better than Moapa, Tanhuato, UC-164, and UC-176-E, but similar to Florida 66, Mesa Sirsa and UC-163. Annual DF yields ranged from 26,453 to 32,660 kg/ha. The highest yields were obtained at three cuttings in April, May, and June; lower, and relatively uniform yields, were recorded during the rest of the year.

Generally, herbage yields were higher in 1980 and decreased in 1981 (table 3). In 1981, yields were better for the 13th and 15th cuttings, March 18 and May 26, respectively. High forage yields during May were attributed to timely application of fertilizer (April 24) followed by maximum rainfall, well distributed, from April 24 to May 26. The lowest yields, for the last 2 cuttings, were attributed to a decrease in stand persistence resulting from an outbreak of *Phytophthora* root rot. At the end of 17 cuttings, the number of plants within cultivars Mesa Sirsa, Florida 66, Tanhuato, Hayden PX-1, UC-163, UC-176-E, and Moapa were 87, 85, 77, 76, 65, 53, and 34% of the original, respectively. The high persistence of the first four cultivars suggests that they can persist for 2 years or possibly more under conditions similar to those of this study.

[3]Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

TABLE 2.—*Dry forage yields of 8 alfalfa cultivars in 10 cuttings in 1980*

Cultivar	Number and date of cutting										Totals
	1 Mar. 20	2 Apr. 21	3 May 19	4 June 20	5 July 22	6 Aug. 20	7 Sep. 22	8 Oct. 21	9 Nov. 20	10 Dec. 18	
	kg/ha										
Az-Hayden-PX-1	3,214	4,497	4,187	3,459	3,055	2,788	3,009	3,385	2,795	2,271	32,660 a[1]
Florida 66	2,454	3,943	3,677	3,580	2,855	2,190	2,540	3,274	2,754	2,600	29,867 a b
Mesa Sirsa	3,108	4,150	3,612	3,352	3,119	2,524	2,643	3,087	2,705	2,247	30,547 a b
UC-163	3,125	3,708	3,870	3,202	2,770	2,330	2,717	2,756	2,395	2,351	29,224 a b
UC-164	2,958	4,210	3,561	3,592	2,487	1,997	2,114	3,083	2,489	1,703	28,194 b
Tanhuato	2,408	3,313	3,642	3,323	2,615	1,886	2,169	2,760	2,406	1,931	26,453 b
Moapa	2,713	3,571	3,606	3,200	2,517	2,146	2,443	2,764	2,432	2,100	27,492 b
UC-176 E	2,721	3,666	3,484	3,045	2,370	1,879	2,239	2,801	2,438	2,501	27,144 b
Mean	2,838	3,882	3,705	3,344	2,724	2,218	2,484	2,989	2,552	2,213	28,949
Rainfall, mm	41.66	21.08	37.85	101.60	49.28	34.04	83.06	110.49	9.14	11.43	499.63
Supplemental sprinkler irrigation, mm[3]	(3)[2] 38.1	(3) 38.1	(3) 38.1	(3) 38.1	(3) 38.1	(3) 38.1	(3) 38.1	(5) 63.5	(5) 63.5	(5) 63.5	459.2

[1] Totals in the same column followed by one or more letters in common do not differ significantly at the 5% probability level as determined by Duncan's multiple range test.

[2] Number in parentheses indicates total sprinkler irrigations per period.

[3] Overhead irrigation was provided for 1 hour. According to J. Ortiz Vélez (personal communication) this is equivalent to approximately 0.5 inch of rainfall.

TABLE 3.—*Dry forage yields of 8 alfalfa cultivars in 7 cuttings in 1981*

Cultivar	Number and date of cutting							Totals
	11 Jan 22	12 Feb 20	13 Mar 18	14 Apr 24	15 May 26	16 July 3	17 Aug 6	
	kg/ha							
Az-Hayden-PX-1	2398	2818	3361	2916	3041	1520	1493	17,547 a b[1]
Florida 66	2459	2894	3473	2549	3634	2137	2388	19,534 a
Mesa Sirsa	2261	2602	3194	2323	3335	1988	1973	17,676 a b
UC-163	1994	2276	2803	2395	2929	1223	1380	15,000 b d
UC-164	1916	2190	2934	2223	3010	1533	1515	15,321 b d
Tanhuato	2007	2381	2981	2345	3299	1645	1311	15,969 b c
Moapa	1957	1987	2833	2275	2668	914	865	13,499 c d
UC-176 E	1834	1827	2540	2023	2695	1175	966	13,060 d
Mean	2103	2372	3015	2381	3076	1517	1486	15,950
Rainfall, mm	29.77	8.38	27.43	28.19	113.28	76.70	46.22	330.17
Supplemental sprinkler irrigation, mm[3]	(5)[2] 63.5	(5) 63.5	(4) 50.8	(5) 63.5	.00	(4) 50.8	(4) 50.8	342.9

[1] Totals in the same column followed by one or more letters in common do not differ significantly at the 5% probability level as determined by Duncan's multiple range test.

[2] Number in parentheses indicate total sprinkler irrigations per period.

[3] See table 2.

TABLE 4.—*Green forage, dry forage, and crude protein yields of 8 alfalfa cultivars*

Cultivar	Total for 10 cuttings in 1980			Total for 7 cuttings in 1981		
	Green forage yield	Dry forage yield	Crude protein yield	Green forage yield	Dry forage yield	Crude protein yield
	kg/ha					
Hayden PX-1	127,668 a[1]	32,660 a	7,135 a	73,610 a c	17,547 a b	3,967 a c
Florida 66	115,391 a b	29,867 a b	6,506 a c	82,721 a	19,534 a	4,500 a
Mesa Sirsa	124,758 a b	30,547 a b	6,702 a b	76,008 a b	17,676 a b	4,185 a b
UC-163	114,608 a b	29,224 a b	6,335 a c	63,579 b d	15,000 b d	3,551 b d
UC-164	105,675 b	28,194 b	5,906 b c	61,596 c d	15,321 b d	3,440 c d
Tanhuato	99,848 c	26,453 b	5,548 c d	66,659 b d	15,969 b c	3,859 a c
Moapa	108,057 a b	27,492 b	5,830 b c	56,756 d	13,499 c d	3,113 d
UC-176 E	104,101 b	27,144 b	5,906 b c	55,233 d	13,060 d	3,030 d

[1] Totals in the same column followed by one or more letters in common do not differ significantly at the 5% probability level as determined by Duncan's multiple range test.

Table 4 presents total GF, DF, and CP yields for 10 and 7 cuttings in 1980 and 1981, respectively. Generally, the best herbage and CP yielders in 1980 were also the best in 1981. According to Horner and Ruelke (5), a yield of 20,000 kg of DF per ha can be considered reasonable. This indicates that, in spite of the *Phytophthora* root rot that affected cuttings 16 and 17, yields were acceptable in 1981.

Table 5 shows total GF, DF, and CP yields and DM content for the 4 cuttings during the season of short photoperiod from November 20, 1980 to March 18, 1981. Florida 66 had the highest yields during this period but they were not significantly different from those of Hayden PX-1, Mesa Sirsa, and UC-163. The lowest forage and CP yield corresponded to UC-176 E.

Mean CP, P, K, Ca, and Mg contents in 1980 were 21.5, 0.37, 3.44, 1.47, and 0.29%, respectively (table 6). During the last 7 cuttings, CP

TABLE 5.—*Green forage, dry forage, and crude protein yields for 4 alfalfa cuttings during the period of short and cool days from November 20, 1980 to March 18, 1981*

Cultivar	Green forage yield	Dry matter content	Dry forage yield	Crude protein yield
	kg/ha	%	*kg/ha*	*kg/ha*
Az-Hayden PX-1	48,724 a b[1]	23.57 a	10,848 a b	2,431 a b
Florida 66	52,664 a	22.83 a	11,423 a	2,596 a
Mesa Sirsa	47,159 a c	23.55 a	10,303 a c	2,398 a c
UC-163	43,424 a c	22.75 a	9,425 a c	2,183 a d
UC-164	37,086 c	24.98 a	8,819 b c	1,947 c d
Tanhuato	41,127 b c	24.35 a	9,301 b c	2,175 a d
Moapa	40,157 b c	23.97 a	8,876 b c	2,005 b d
UC-176 E	36,720 c	24.10 a	8,240 c	1,886 d

[1] Means in the same column followed by one or more letters in common do not differ significantly at the 5% probability level as determined by Duncan's multiple range test.

content was higher than for the first 10 cuttings; however, the opposite was true for K content. All cultivars except UC-164 contained more than 3% K (table 6), the herbage tissue content that Smith (7) showed necessary for obtaining high forage yields under Wisconsin conditions. The fact that tissue levels of K observed in this test exceeded 3% demonstrates that the soil and fertilizer probably provided sufficient K throughout the experiment.

RESUMEN

En el Centro de Investigación y Desarrollo Agrícola de Fortuna se estudiaron la productividad y la persistencia de 8 cultivares no resistentes de alfalfa por 583 días consecutivos. El suelo fue de la serie San Antón, con buen drenaje, tanto superficial como interno, y con pH 7.3. El herbicida Trifluralin (1.4 Kg/ha ingrediente activo) se incorporó a los primeros 5 cm

TABLE 6.—*Crude protein and mineral contents of 8 alfalfa cultivars*

Cultivar	Mean for the 10 1980 cuttings					Mean for the 1981 cuttings		
	Crude protein	Phosphorus	Potassium	Calcium	Magnesium	Crude protein	Phosphorus	Potassium
					%			
Az-Hayden PX-1	21.8	0.36	3.48	1.58	0.29	22.6	0.34	3.08
Florida 66	21.8	0.37	3.47	1.44	0.29	23.0	0.36	3.18
Mesa Sirsa	21.9	0.38	3.52	1.45	0.30	23.7	0.36	3.23
UC-163	21.7	0.38	3.40	1.47	0.29	23.7	0.36	3.04
UC-164	20.9	0.37	3.34	1.53	0.30	22.4	0.34	2.94
Tanhuato	21.0	0.37	3.40	1.39	0.29	24.1	0.36	3.19
Moapa	21.2	0.37	3.49	1.45	0.29	23.0	0.36	3.10
UC-176 E	21.9	0.38	3.41	1.48	0.30	23.2	0.35	3.15
Mean	21.5	0.37	3.44	1.47	0.29	23.2	0.35	3.11

[1] Means of 4 replicates.

de suelo el día anterior a la siembra. La semilla, inmediatamente después de inocularla con la cepa de bacteria apropiada, se sembró a razón de 13.5 kg/ha en surcos de 1.5 a 2.0 cm. de profundidad. Cada parcela consistió de 8 surcos a 30.5 cm de separación por 5.50 m de largo.

Después de 2 meses de establecidas, las plantas se cortaron a 5 cm. de alto cada 4 a 5 semanas aproximadamente. En el 1980, se cortó 10 veces y en el 1981 7 hasta el día 6 de agosto. Generalmente, se aplicaron de 3 a 5 riegos por aspersión mensuales, dependiendo de la cantidad de lluvia. La plantación se abonó a razón de 224 y 672 kg de P y K/ha y año, respectivamente.

En el 1980 se obtuvieron los siguientes rendimientos de forraje seco y proteína bruta (kg/ha): Hayden PX-1, 32,660 y 7,135; Florida 66, 29,867 y 6,506; Mesa Sirsa, 30,547 y 6,702; UC-163, 29,224 y 6,335; UC-164, 28,194 y 5,906, Tanhuato, 26,453 y 5,548; Moapa, 27,492 y 5,830; y UC-176 E, 27,144 y 5,906. Los rendimientos de forraje seco y proteína bruta de los 7 cortes en 1981 fueron más bajos, pero bajaron en la misma proporción que en 1980.

Las cultivares más productivas durante el período de días cortos (20 de noviembre de 1980 al 18 de marzo de 1981) fueron Florida 66, Hayden PX-1, Mesa Sirsa y UC-163.

El contenido medio de proteína bruta, fósforo, potasio, calcio y magnesio de las 8 cultivares en los 10 cortes del 1980 fue 21.5, 0.37, 3.44, 1.47 y 0.29%, respectivamente; el contenido medio de proteína bruta, fósforo y potasio de las 8 cultivares en los 7 cortes del 1981 fue 23.2, 0.35 t 3.11%, respectivamente. Un nivel de potasio de 3% en los tejidos de la planta se considera adecuado para que la plantación sostenga buenos rendimientos y persistencia.

Se concluye que las 4 cultivares de más alta productividad (Hayden PX-1, Florida 66, Mesa Sirsa y UC-163) sobrepasan ampliamente la producción de 20,000 kg por hectárea y año, considerada como la mínima requerida para cultivos comerciales, y que la alta persistencia de la plantación de estas 4 cultivares demuestra que este cultivo puede perdurar por 2 años, o posiblemente más, en suelos aptos bajo condiciones de riego y bien administradas.

LITERATURE CITED

1. Almodóvar-Vega, L. and Vélez-Santiago, J., 1980. Evaluation of preplant incorporated chemicals for weed control on alfalfa in a Vertisol, J. Agric. Univ. P. R. 64 (1):129–30.
2. Anonymous, 1975. Pelleting small legume seeds with Pelinoc, Information Bull. 1622, Nitragin Co. Res. Dep.
3. Burriel-Marti, F. and Ramírez-Muñoz, J., 1960. Flame photometry, a manual of methods and application, 3rd. rep. Elsevier Publ. Co., Amsterdam, Holland.

4. Hine, R. B., Gray, F. A. and Schonhorst, M. H., 1972. *Phytophthora* root rot of alfalfa in Arizona, Plant Dis. Rep. 56:472–3.
5. Horner, E. S. and Ruelke, C. O., 1980. Florida 77 alfalfa and recommended management practices for its production, Cir. S-271, Univ. Florida, Gainesville, Fla.
6. Riera, A., 1955. The method of foliar diagnosis as applied to sugarcane, II, The chemical analyzes of sugarcane-leaf samples, Agric. Exp. Stn. Univ. P. R. Bull. 123.
7. Smith, D., 1979. High levels of potassium are needed to maintain high alfalfa herbage yields, Report of the 26th Alfalfa Improvement Conference, South Dakota State Univ., Brookings, South Dakota, June 6–8, 1978.
8. Snedecor, G. W. and Cochran, W. G., 1967. Statistical Methods, 6th ed, The Iowa State Univ. Press, Ames, Iowa.
9. Vélez-Santiago, J., Arroyo-Aguilú, J. A., Torres-Rivera, S. and Corchado-Juarbe, N., 1983. Performance and chemical composition of 18 nondormant alfalfa cultivars at the Lajas Valley, J. Agric. Univ. P. R. 67 (3):204–12.