Potassium Supplying Power of the Major Upland Inceptisols of Puerto Rico[1]

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ABSTRACT

Capacity of the nine most extensive upland Inceptisols of Puerto Rico to supply potassium (K) was determined through intensive cropping in pots with Pangola grass during 4 consecutive years. In addition, field experiments were conducted on two of these soils, Múcara and Pandura, for comparison.

Seven of the Inceptisols tested formed under a udic moisture regime. They supplied an average of 279/kg of K/ha to Pangola grass during the first year, and then dropped to 110, 114, and 93 kg/ha for the second, third and fourth years, respectively. The average of 106 kg/ha for the last 3 years probably represents the long term capacity of this group to supply K to plants.

The amount of K released by Múcara and Pandura soils (both udic Inceptisols) in the field experiments agreed fairly well with values obtained in the pot experiments.

Two of the Inceptisols tested formed under a ustic moisture regime released and average of 507 kg of K/ha during the first year, and then 254, 233, and 140 kg/ha the last 3 years. The average K release per year for the last 3 years was 209 kg/ha. However, the long range K supplying capacity of these soils is probably lower than this value.

The exchangeable K values obtained at the beginning of the pot experiment were significantly correlated with the amount of K extracted by Pangola grass during the first year of cropping in pots, whereas the HNO_3-soluble K values were correlated with the average release of K during the last 3 cropping years.

INTRODUCTION

According to Wiklander (20) potassium occurs in soils in four different forms: exchangeable, in soil solution, fixed and contained in the mineral matrixes. Rich (16) postulates that most of the potassium that is readily available to plants exists as exchangeable ions, and as this form is exhausted by crops it is replaced at varying rates by the K-bearing minerals in the soil. The amount of exchangeable K in soils depends on the origin, age, mechanical composition and rates of fertilization. There is considerable information on the K-supplying power of soils from the temperate region (6, 7, 10, 11, 14, 15, 17). This research work has been carried out mainly in U.S.A. under greenhouse conditions. In most of them exchangeable and HNO_3-soluble K has been correlated with plant uptake. In only few cases the exchangeable potassium values did not correlate with plant uptake (15).

There is plenty of available information on potassium fertilization on

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tropical soils (5, 8, 18, 19). On the other hand, the capacity of tropical soils to supply K to crops has been investigated in a fragmentary way with no bearing to the new system of soil taxonomy (3, 4, 5, 12, 13).

Inceptisols are extensively used throughout the tropics and they are more so in the humid than on semihumid regions. These soils are extensively used in Ghana for cocoa growing and in Tanzania for small grain farming (5).

The upland Inceptisols of Puerto Rico cover about 185,000 ha in the humid mountain region (the area under udic moisture regime). They include soils of the Múcara, Quebrada, Caguabo, Juncos, Pandura and Utuado series. About 50,000 ha in the semiarid uplands (ustic moisture regime) includes soils of the Descalabrado and Jácana series. Except for the Pandura and Utuado soils these soils are derived mainly from volcanic material, predominantly andesitic tuffs. Pandura and Utuado soils are derived from quartz diorites. Most of the Inceptisols of the semi-arid (ustic) region are used as range; those of the humid (udic) uplands are used for pastures, tobacco, root crops and extensively managed coffee.

Vicente-Chandler et al. (19) showed that intensively managed tropical grasses under cutting management took up about 420 kg of K/ha. yr and responded to applications of 335 kg of K/ha. yr on Ultisols. Abruña et al. (1) found that intensively managed coffee responded to applications of 335 kg of K/ha. yr. Caro-Costas et al. (9) found that plantains grown on an Ultisol responded to the application of 450 kg of K/ha. yr.

Abruña et al. (2) found that on the average, the major Ultisols and Oxisols of Puerto Rico supplied 250 of kg of K/ha. yr to intensively managed grasses during the first year and 90 and 50 kg of K/ha. yr, respectively over a subsequent 3 yr period.

There is little information available on the K supplying capacity of the upland Inceptisols of Puerto Rico, which are typical of vast areas in the tropics and have a great potential for meat and milk production.

This paper present the results of a 4 yr experiment carried out to determine the capacity of the major upland Inceptisols of Puerto Rico to supply K to intensively managed grasses.

MATERIALS AND METHODS

Soil samples were taken to a depth of 30 cm from each of 111 sites, 89 representing the Inceptisols of the humid uplands (Múcara, Sabana, Caguabo, Juncos, Pandura and Utuado soils) and 22 the semi-arid uplands, (Descalabrado and Jácana soils). The number of samples representing each soil series was in proportion to the area covered by the soil and ranged from 7 for the Utuado soils which covers 10,000 ha to 25 for Múcara soils which cover 67,000 ha.

The soil from each site was air dried, sieved, limed to about 80% base saturation and 15 kg placed in 12 liter pots. The amount of surface and subsurface soil potted for each site was in proportion to the actual thickness of each layer as it occurred in the field. The surface area of each pot was .545 sq ft equivalent to $\frac{1}{80,000}$ of an acre. The weight of a furrow slice for each soil was determined using volume weight values for each soil layer. This value was used to convert the pot data into per

FIG. 1.—Layout of experimental plots. A wire mesh was used to confine grass growth to the pot area.

hectare basis. Phosphorus (as triple super) was applied at the rate of 112 kg/ha once every year and N (as urea) at the rate of 673/kg of N/ha. yr divided in 6 equal applications yearly, one after each cutting.

Pangola grass was planted in all pots. The experiment was initiated when a solid stand was established (figure 1). The Pangolagrass was harvested every 2 months, dried, and weighed to determine dry matter yields and the K content.

The soil was thoroughly wetted twice weekly by flooding the pots for 2 hours. The excess water was then drained from each pot and later used to irrigate the same pot, so that K in the leachates was returned to the soil. Water containing less than 2 p/m of K was used for irrigation.

Soil samples from each pot were taken at the beginning and at the end of the experiment and analyzed for exchangeable and HNO_3-soluble K. In addition, all soil samples taken at the beginning of the experiment were analyzed for pH, organic matter content, cation exchange capacity, and exchangeable Ca and Mg.

To find out if the capacity of a soil to supply K as determined by cropping in pots is related to the actual K supplying capacity of the same soil under field conditions, field experiments were carried out concurrently with the greenhouse work. Three experiments were carried out at different locations on Múcara soil and one on Pandura soil over the same 4-yr. period. Two soil samples from each area of the field experiment were used in the pot experiment. Potassium supplying capacity of the soils in the field experiments was determined in the same way as in the pot study—by cutting the forage every 2 months and determining dry matter yield and K content of the forage. As in the pot experiment, the grass in all field experiments received 112 kg of P kg/ha.yr in one application and 672 kg/ha.yr of N divided in 6 equal applications during the year. Plots were 4 × 4 m had a solid stand of pangolagrass and were not irrigated.

RESULTS AND DISCUSSIONS

Table 1 shows that pH of the surface soil of these Inceptisols ranged from 5.35 to 6.70 and was slightly higher (6.45–6.70) for the ustic than for the udic (5.5–6.3). Organic matter content of the surface soils ranged from 3.08 to 5.34 percent. Exchangeable Ca in the udic soils varied widely—from 3.91 meq/100 g in the Utuado and Pandura surface soil to 17.59 meq/100 g in the Caguabo soil. The ustic soils had exchangeable Ca contents exceeding 22 meq/100 g of soils. Exchangeable Mg also varied widely from a low of 1.38 meq/100 g in the Pandura and Utuado surface soils to between 6.78 and 12.62 meq/100 g of soil in the other soils. Exchangeable K contents ranged from 0.16 to 0.38 meq/100 in the udic surface soils to .85 meq/100 g in the ustic soils. Cation exchange capacity of the surface soils also varied widely from 5.6 to 35.11 meq/100 g of soil as determined by sum of the cations, and from 7.40 to 34.67 meq/100 g of soil as determined by the ammonium acetate method.

Table 2 shows that the udic Inceptisols initially contained much less exchangeable K (195 kg/ha) and HNO_3 soluble K (440 kg/ha) than the ustic, which had an average of 518 kg/ha of exchangeable K and 1,410 kg/ha of HNO_3-soluble K. On the average, the udic soils had a total of 635 kg/ha of available K and the ustic 1,928 kg/ha.

On the average, Pangolagrass extracted a total of 610 kg of K/ha from

TABLE 1.—*Chemical properties of the nine upland Inceptisols studied*

Soil series	pH	Organic matter	Exchangeable bases			Exchange capacity	
			Ca	Mg	K	Sum of cations	NH_4OAc extraction
				Me/100 g soil		*Me/100 g soil*	
Múcara-surface	5.85	4.89	15.21	11.59	.38	27.18	29.78
Múcara-subsoil	6.00	2.96	16.16	12.52	.18	28.86	30.36
Quebrada-surface	6.00	4.06	17.18	12.62	.30	30.1	31.07
Quebrada-subsoil	6.00	2.38	18.33	12.00	.17	30.5	31.40
Caguabo-surface	6.30	3.96	17.59	9.49	.37	27.45	26.15
Caguabo-subsoil	6.05	2.07	17.31	8.95	.26	26.52	26.03
Sabana-surface	5.60	3.78	9.94	6.78	.33	17.05	20.13
Sabana-subsoil	5.50	2.10	10.38	8.12	.25	18.75	20.74
Pandura-surface	5.85	3.08	3.91	1.38	.31	5.60	7.40
Pandura-subsoil	5.65	1.82	3.38	1.28	.25	4.91	7.31
Utuado-surface	5.70	2.91	4.86	2.98	.15	8.55	10.71
Utuado-subsoil	5.65	1.30	5.01	2.68	.08	8.27	10.12
Juncos-surface	5.35	4.07	14.04	10.25	.16	24.45	29.93
Juncos-subsoil	5.70	2.90	14.60	13.80	.08	28.48	30.06
Jácana-surface	6.45	5.34	22.96	11.29	.86	35.11	34.67
Jácana-subsoil[1]	6.75	3.76	27.52	12.37	.37	40.26	35.91
Descalabrado-surface	6.70	5.12	22.48	11.03	.84	34.35	30.75
Descalabrado-subsoil[1]	6.65	3.36	23.72	10.09	.34	34.15	30.16

[1] The subsoil of Descalabrado and Jácana soils contain some free carbonates.

TABLE 2.—*Potassium extracted from nine upland Inceptisols during 4 years of continuous cropping with Pangola grass in pots and before and after four croppings*

Soil type	Sites studied	K in soil at start of the experiment			K extracted by cropping with Pangola	K in soil after 4 years of cropping		
		Exchange-able K	HNO_3 ex-tractable K	Total avail-able K		Exchange-able K	HNO_3 ex-tractable K	Total avail-able K
Udic	*Number*	*Kg/ha*	*Kg/ha*	*Kg/ha*	*Kg/ha*	*Kg/ha*	*Kg/ha*	*Kg/ha*
Múcara Vertic Eutropepts	25	271	333	604	779	108	264	372
Quebrada Typic Eutropepts	13	212	545	757	561	102	368	470
Caguabo Lithic Eutropepts	13	185	284	469	647	99	287	386
Sabana Lithic Distropepts	10	248	272	520	632	90	183	273
Pandura Typic Eutropepts	14	240	1102	1342	784	68	760	828
Utuado Typic Humitropepts	7	99	208	307	496	62	184	246
Juncos Vertic Eutropepts	7	110	336	446	371	91	235	326
Average for Udic		195	440	635	610	89	326	415
Ustic								
Jácana Vertic Ustropepts	5	568	1597	2165	1083	195	1272	1467
Descalabrado Lithic Vertic Ustropepts	17	467	1223	1690	1188	137	641	778
Average for Ustic		518	1410	1928	1136	166	957	1123
Overall average		267	656	922	726	106	466	572

TABLE 3.—*Annual yields, K contents, and K uptake by Pangola grass growing in pots filled with nine upland Inceptisols during a 4-year period*

Soils	First year			Second year			Third year			Fourth year			Average for 4 years			Average K uptake during last 3 years
	Dry matter yield	K content	K uptake	Dry matter yield	K content	K uptake	Dry matter yield	K content	K uptake	Dry matter yield	K content	K uptake	Dry matter yield	K content	K uptake	
	Kg/ha	*%*	*Kg/ha*	*Kg/ha*	*%*	*Kg/ha*	*Kg/ha*	*%*	*Kg/ha*	*Kg/ha*	*%*	*Kg/ha*	*Kg/ha*	*%*	*Kg/ha*	*Kg/ha/yr*
Udic Inceptisols																
Múcara	43,613	.87	379	32,397	.47	151	35,220	.38	134	29,575	.39	115	35,201	.55	195	133
Quebrada	40,192	.71	284	29,492	.33	96	30,902	.30	94	25,770	.34	87	31,589	.44	140	92
Caguabo	43,182	.63	272	33,059	.40	133	35,992	.37	134	29,267	.37	108	35,375	.46	162	125
Sabana	41,824	.91	380	28,820	.34	97	25,885	.33	86	20,870	.33	69	29,350	.54	158	84
Pandura	41,355	.86	354	36,423	.44	159	37,358	.41	152	27,577	.43	119	35,678	.55	196	143
Utuado	32,675	.61	198	26,818	.33	87	33,553	.37	124	27,572	.32	87	30,155	.41	124	99
Juncos	33,239	.55	181	17,456	.29	50	25,078	.29	73	21,164	.32	67	24,234	.38	93	63
Average	39,440	.71	279	29,209	.38	110	31,998	.36	114	25,970	.36	93	31,654	.47	153	106
Ustic Inceptisols																
Jácana	45,770	.98	447	48,194	.50	241	44,409	.55	244	32,770	.45	147	42,786	.63	270	211
Descalabrado	47,265	1.20	566	42,763	.62	267	41,190	.54	221	31,750	.42	134	40,742	.73	297	207
Average	46,518	1.09	507	45,479	.56	254	42,800	.54	233	32,260	.43	140	41,764	.68	284	209

the udic Inceptisols over a 4-yr period as compared with 1,136 kg of K/ha from the ustic Inceptisols. On the average, Pangolagrass extracted 96% of the total available K from the udic and 60% from the ustic Inceptisols. Available K extracted by Pangolagrass varied from 58% from the Pandura to 162% form the Utuado soil.

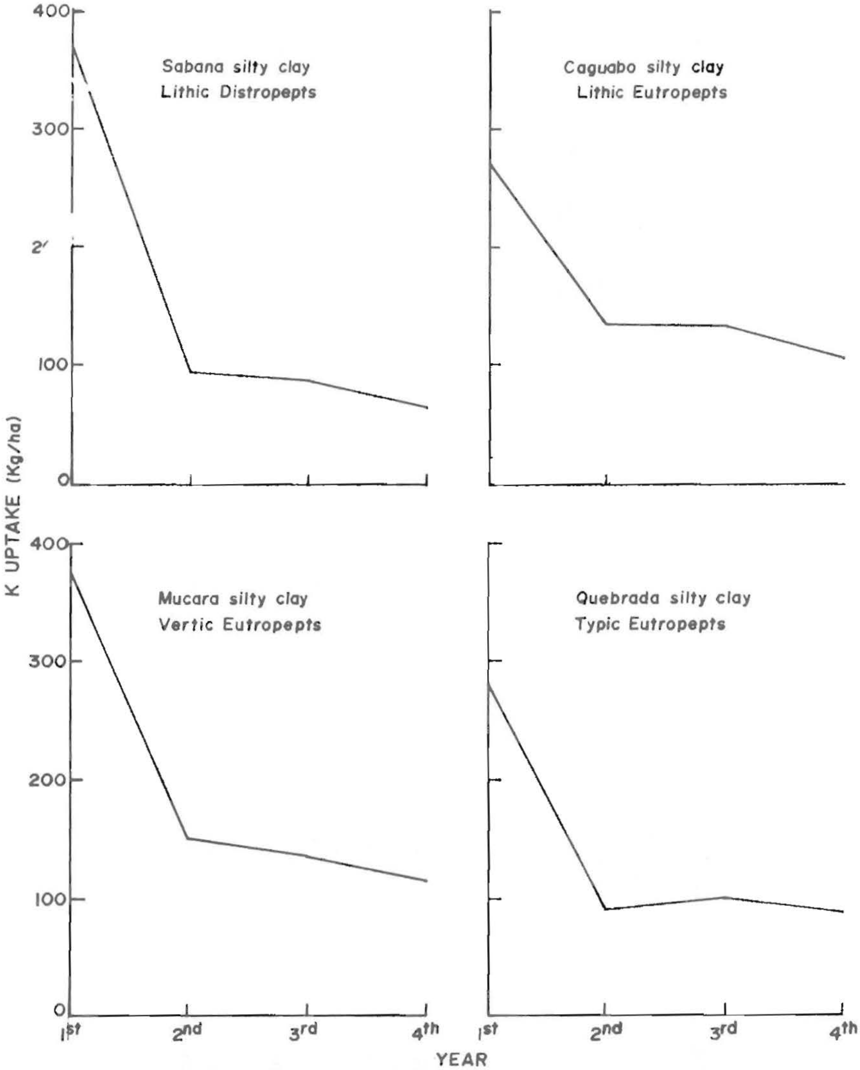

FIG. 2.—Potassium supplying power of the most important upland Udic Inceptisols from Puerto Rico as determined by intensive cropping with Pangola grass in pots over 4 consecutive years.

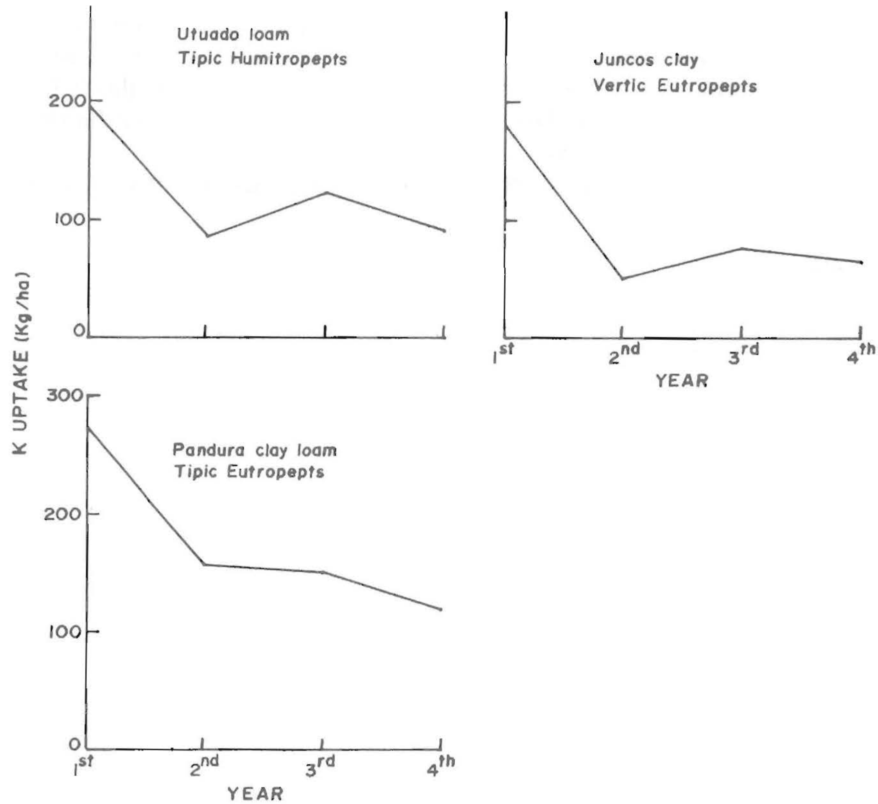

FIG. 2—*Continued*

At the end of 4 consecutive years of cropping with Pangolagrass, the udic Inceptisols still contained on the average 46% of the original exchangeable K content and 74% of the original HNO_3-soluble K content. The ustic group had an average of 32% of original exchangeable K and 68% of the HNO_3-soluble K. After 4 consecutive years of cropping the soils as a group still contained 40% of the original exchangeable K content and 70% of the HNO_3-soluble K content.

Table 3 and figure 2 show that K released to pangolagrass by the various soils during the first year was invariably high and dropped off sharply during subsequent years. There were marked differences in the amount of K extracted by pangolagrass among different udic Inceptisols, particularly during the first year. For example, during the first year of cropping the Múcara, Sabana and Pandura soils released over 350 kg of K/ha whereas the Utuado and Juncos soils released only an average of 189 kg of K/ha. The Caguabo and the Sabana soils released an average of 278 kg/ha. Extraction during the last 3 years, ranged from 63 to 99 kg/

ha.yr for Juncos, Quebrada, Sabana and Utuado soils and from 125 to 143 kg/ha.yr for Múcara, Caguabo, and Pandura soils. Abruña et al (2) found that upland Ultisols developed from parent material similar to that of Múcara, Caguabo, and Quebrada soils supplied about 90 kg/ha.yr to pangolagrass during 3 consecutive years of cropping.

The udic Inceptisols as a group released an average of 279 kg of K/ha

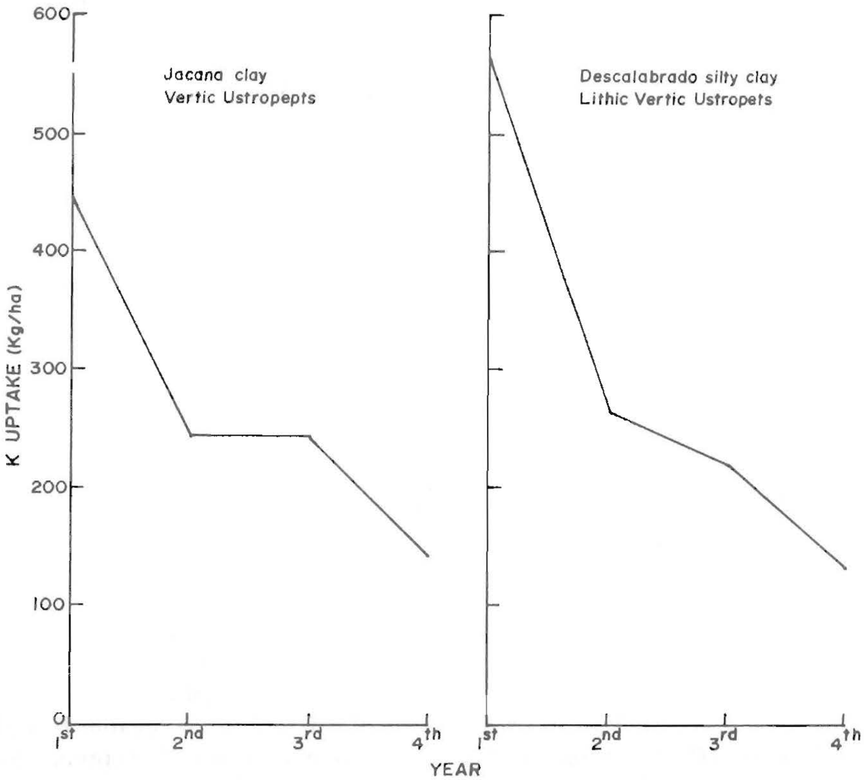

FIG. 3.—Potassium supplying power of the two most important upland Ustic Inceptisols from Puerto Rico as determined by intensive cropping with Pangola grass in pots over 4 consecutive years.

during the first year and then dropped to 110, 114 and 93 kg/ha for the second, third and fourth year, respectively. The average of 106 kg/ha for the least 3 years probably represents the long term K supplying power of this group of soils (table 3 and figure 4).

Table 3 and figure 3 show that the two ustic Inceptisols, Descalabrado and Jácana, released 566 and 447 kg of K/ha.yr during the first year, respectively. During the last 3 years the Descalabrado soil released 267, 221 and 134 kg/ha.yr whereas the Jácana released 241, 244 and 147 kg/ha.yr, respectively.

During all years the ustic Inceptisols as a group released about twice as much K to Pangolagrass as did the udic group (Table 3 and figure 4). During the first year this group released an average of 507 kg of K/ha followed by 254, 233 and 140 kg of K/ha.yr for the last 3 years, respectively. The release patterns shown in figures 3 and 4 seem to indicate

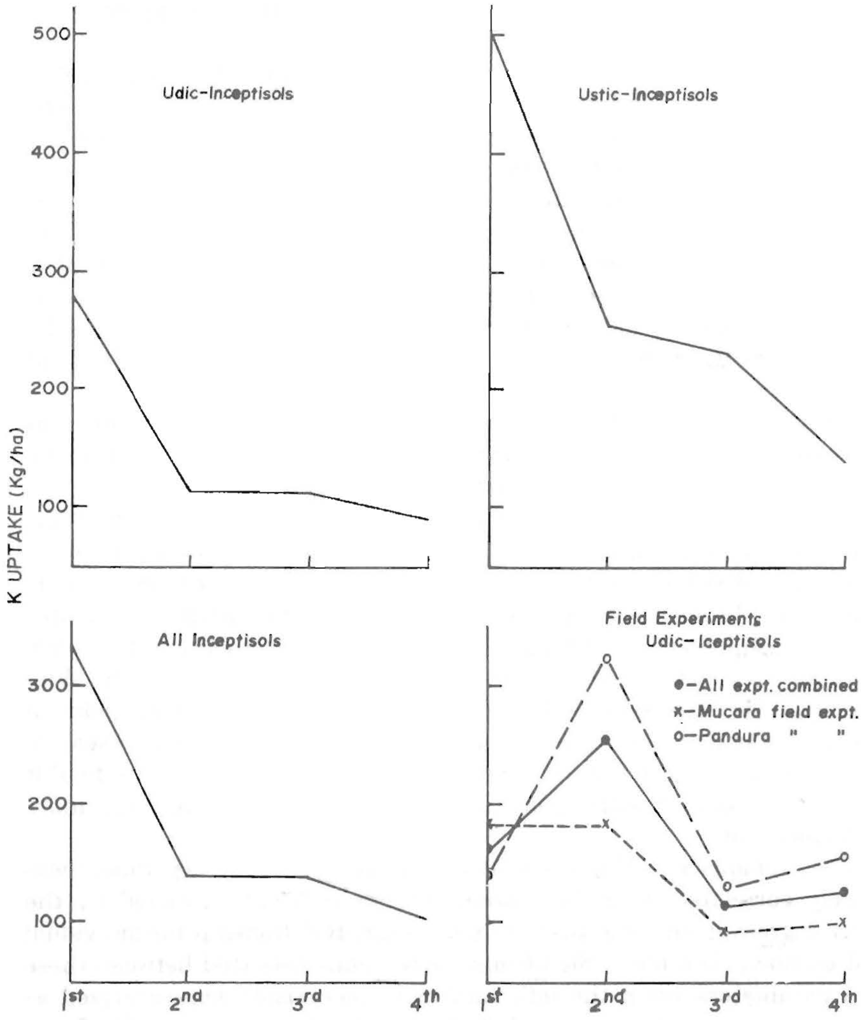

FIG. 4.—Potassium supplying power of Udic and Ustic groups of Inceptisols from Puerto Rico as determined by intensive cropping with Pangola grass in pots over 4 consecutive years. Field experiment data included for comparison.

that the long range K supplying power of these soils may be in the neighborhood of 110 kg of K/ha.yr.

Dry matter yields obtained in the pot experiment were substantially higher than those obtained under field conditions. Pangolagrass, on Múcara soil, under field conditions, produced 56, 81, 50 and 58% of the extrapolated yields of dry matter produced in pots during the 4 consecutive years of cropping with an average of 60% for the 4 years. On the Pandura soil, yields in the field experiment were 43, 97, 73 and 97% of those obtained in the pots. The average yield for the 4 cropping years was 75% of that obtained in pots.

In spite of lower forage yields obtained in the field experiments (table 4), K uptake was reasonably close to that obtained in the pot study. For example, the average K released by Múcara and Pandura soils in the pot experiment was 195 kg/ha (table 3), whereas in the field experiments it was 170 kg/ha (table 4). The K released by the Múcara soils in the pot experiment during the last 3 years of cropping averaged 133 kg/ha whereas in the field experiments it amounted to 143 kg/ha. The total K released by Múcara soils in the pot experiment was 779 kg/ha as compared with 626 kg/ha for the field experiments. The Pandura soils released 784 kg of K/ha in pots compared with 841 kg/ha in the field experiment.

These results indicate that the data on K release by soils obtained in pot experiments are very similar to those obtained in field experiments which are much more difficult and expensive to conduct.

On the other hand, K content of pangolagrass under field conditions was considerably higher than that of pangolagrass growing in pots. Marked K deficiency symptoms occurred and yields were low when K content of the forage approached 0.60%. In the pots pangolagrass produced much higher yields than in the field, yet did not exhibit deficiency symptoms even when the forage contained less than 0.4% of K. Why pangolagrass must apparently contain more K to produce high yields in the field than in pots is not clear and suggests an area for further research. The grass growing in pots was wetted frequently, whereas in the field it suffered periodic drouths. Also pangolagrass in the pots received more reflected light.

The exchangeable K in the soil at the beginning of the experiment was closely correlated with the amount of this nutrient extracted by the pangolagrass during the first cropping year. Relationship for individual soil is shown in table 5. Significant correlations persisted between these two parameters when the udic and ustic Inceptisols were analyzed as separate groups, figure 5 and 6. However, there was no significant correlation between the exchangeable K in the soil at the beginning of the experiment and the uptake of K during the last 3 years of cropping,

TABLE 4.—*Annual yield and potassium uptake by Pangola grass grown on 4 field experiments*

Soil	Site	First Year			Second Year			Third Year			Fourth Year			Average				Total uptake
		Dry matter	K content	K uptake	Dry matter	K content	K uptake	Dry matter	K content	K uptake	Dry matter	K content	K uptake	Dry matter	K content	K uptake	Average K uptake for 3 yr	
		Kg/ha	*%*	*Kg/ha*	*Kg/ha*	*%*	*Kg/ha*	*Kg/ha*	*%*	*Kg/ha*	*Kg/ha*	*%*	*Kg/ha*	*Kg/ha*	*%*	*Kg/ha*	*Kg/ha*	*Kg/ha*
Múcara	Aguas Buenas	19,086	.50	96	23,263	.65	150	18,191	.58	105	19,990	.55	111	20,133	.57	115	122	462
Múcara	Saldaña	25,099	.78	195	37,331	.77	287	24,929	.54	136	15,553	.61	95	25,729	.69	178	172	717
Múcara	Orocovis	29,130	1.02	296	18,377	1.04	192	10,032	.77	77	15,529	.91	141	18,267	.97	177	137	706
Average for Múcara		24,438	.80	196	26,324	.80	209	17,717	.60	106	17,024	.68	115	21,376	.73	157	143	626
Pandura	Yabucoa	17,799	.93	165	35,532	1.03	367	27,236	.53	144	26,736	.62	165	26,826	.78	210	225	841
Average for all sites		22,779	.83	188	28,626	.87	249	20,096	.58	115	19,452	.66	128	22,739	.75	170	164	680

TABLE 5.—*Relationship between various soil K values and uptake of this nutrient by Pangolagrass growing in pots*

Soil	Exch K at the beginning vs K uptake during first year	Exch K at the beginning vs average K uptake during last 3 years	HNO_3 soluble K at the beginning vs average K uptake during last 3 years	HNO_3 soluble K at the end vs K uptake during last 3 years	Total available[1] K vs total K extracted in 4 years
Múcara	$r = .78^{**}$ $Y = -1090.23 + 638.90 \log_e x$	Not Significant	$r = .66^{**}$ $Y = -184.17 + 132.66 \log_e x$	$r = .60^{**}$ $Y = -162.22 + 118.0 \log_e x$	$r = .88^{*}$ $Y = -1216.11 + 686.4 \log_e x$
Quebrada	Not Significant	Not Significant	$r = .84^{**}$ $Y = -44.64 + 59.90 \log_e x$	$r = .88^{*}$ $Y = 49.32 + .106x$	$r = .89^{**}$ $Y = -1314.3 + 716.66 \log_e x$
Caguabo	$r = .88^{*}$ $Y = -2488.75 + 1245.87 \log_e x$	$r = .92^{**}$ $Y = 52.6 + .36x$	$r = .74^{**}$ $Y = -331.90 + 200.85 \log_e x$	$r = .67^{**}$ $Y = 20.4 + .452x$	$r = .94^{**}$ $Y = -824.66 + 533.42 \log_e x$
Sabana	$r = .93^{**}$ $Y = -69.74 + 1.84x$	$r = .78^{**}$ $Y = 42.23 + .148x$	Not Significant	Not Significant	$r = .81^{**}$ $Y = -142.95 + 1.52x$
Juncos	$r = .74^{**}$ $Y = 16.9 + 2.19x - .006x^2$	Not Significant	Not Significant	Not Significant	Not Significant
Pandura	$r = .76^{**}$ $Y = -1505.76 + 800.0 \log_e x$	Not Significant	$r = .89^{**}$ $Y = 36.72 + .093x$	$r = .62^{*}$ $Y = 71.39 + .083x$	$r = .80^{**}$ $Y = 12.9 + .66x$
Utuado	Not Significant	Not Significant	$r = .72^{*}$ $Y = 2.11 + .465x$	Not Significant	$r = .81^{**}$ $Y = -171.68 + 2.25x$
Jácana	Not Significant	Not Significant	$r = .72^{**}$ $Y = 125.90 + .044x$	$r = .74^{*}$ $Y = 115.02 + .066x$	Not Significant
Descalabrado	$r = .81^{**}$ $Y = -49.47 + 1.89x - .0009x^2$	$r = .69^{**}$ $Y = -101.85 + 1.094x - .0006x^2$	$r = .85^{**}$ $Y = -734.77 + 320.37 \log_e x$	$r = .86^{**}$ $Y = 51.82 + .233x$	$r = .84^{**}$ $Y = 267.25 + .53x$
Udic Group	$r = .75^{**}$ $Y = -1196.43 + 679.10 \log_e x$	$r = .47^{*}$ $Y = 67.0 + .189x$	$r = .55^{**}$ $Y = -122.27 + 97.95 \log_e x$	$r = .45^{**}$ $Y = 73.83 + .103x$	$r = .81^{**}$ $Y = 304.91 + .486x$
Ustic Group	$r = .65^{**}$ $Y = -1305.58 + 707.31 \log_e x$	$r = .48^{*}$ $Y = 88.50 + .223x$	$r = .67^{**}$ $Y = -580.50 + 266.43 \log_e x$	$r = .72^{**}$ $Y = 81.82 + .149x$	$r = .78^{*}$ $Y = 334.09 + .44x$

[1] Total available includes exchangeable + HNO_3 soluble K.

* Significant at the 5% level (Duncan's multiple range).

** Significant at the 1% level (Duncan's multiple range).

except in the case of Caguabo and Sabana soils which showed a high correlation.

The HNO_3-soluble K in the soil at the beginning of the experiment correlated with the average uptake of this nutrient by pangolagrass during the last 3 cropping years as shown in table 5 and figures 7 and 8. In general, the HNO_3-soluble K values did not correlate well with the

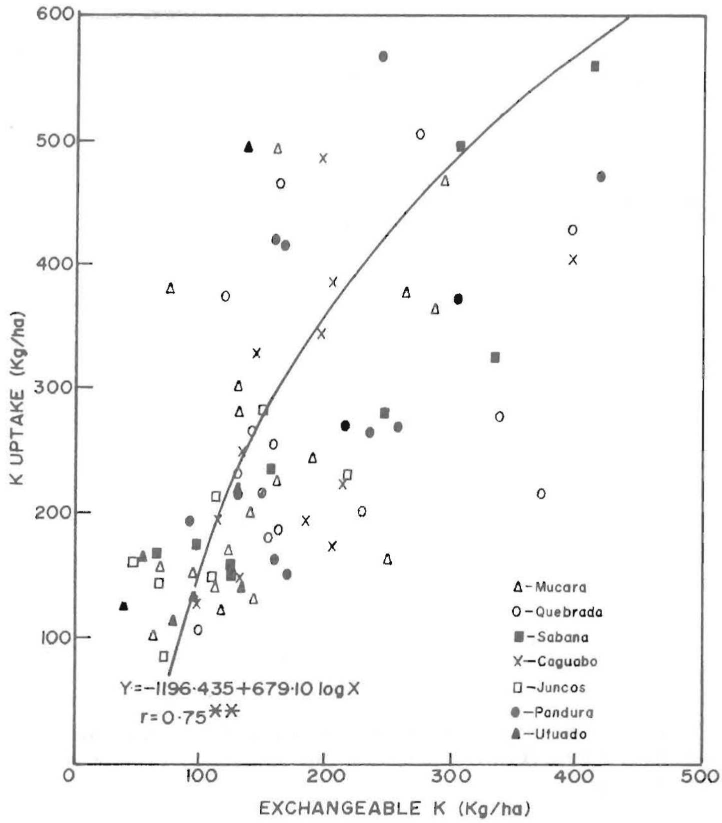

FIG. 5.—Relationship between the exchangeable K content of the most important Udic Inceptisols from Puerto Rico and uptake of this nutrient by Pangola grass during the first cropping year in pots.

uptake of K during the first year of cropping either when soils were considered individually or combined into groups. Only the Caguabo soil exhibited a good correlation between these K values (data not shown).

There was a highly significant correlation between the total available K (exchangeable + HNO_3-soluble) determined at the beginning of the experiment and the total K uptake by Pangolagrass during the 4-year

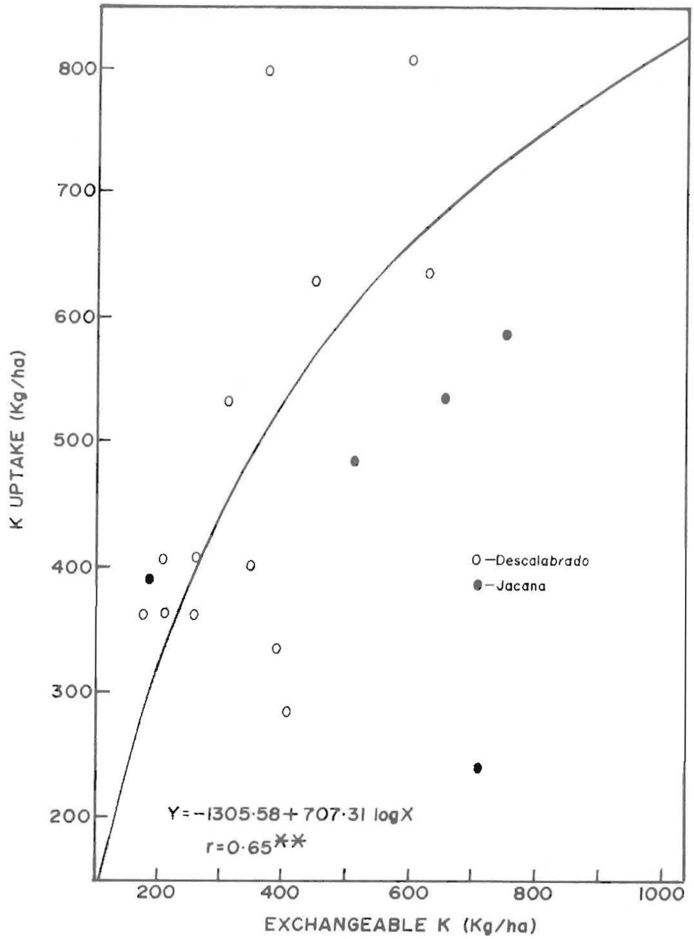

FIG. 6.—Relationship between the exchangeable K content of the most important Ustic Inceptisols from Puerto Rico and uptake of this nutrient by Pangola grass during first cropping year in pots.

cropping period. This correlation was exhibited both by individual soils (except Juncos and Jacana) and by the ustic and udic grass. In almost all cases r-values were over 0.8.

After 4 years of cropping, the HNO_3-soluble K left in the soil correlated significantly with the uptake of K during the last 3 years, both when soils were analyzed individually and in udic or ustic groups, except for Sabana, Juncos, and Utuado soils. This is further evidence that the HNO_3-soluble K is a good indicator of the long term K supplying capacity of the upland Inceptisols from Puerto Rico.

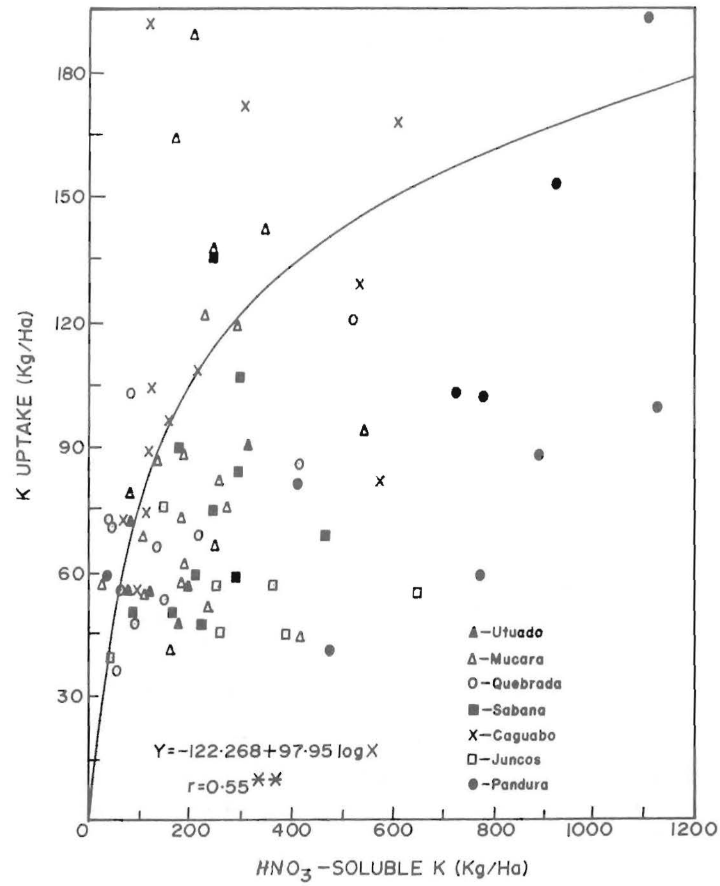

FIG. 7.—Relationship between the HNO_3 soluble K content of the most important Udic Inceptisols and uptake of this nutrient by Pangola grass during the last 3 cropping years in pots.

The data presented show that exchangeable K is a good criterion for estimating the capacity of the udic Inceptisols to supply this nutrient to grasses during the first year and the HNO_3-soluble K values provide a reasonable guide for predicting the long term supplying capacity of these soils. The ustic Inceptisols contain more exchangeable K than the udic and thus can supply K from this form for more than one year. However, the long term capacity of these soils to supply K can also best be predicted from their HNO_3-soluble K contents.

It can be concluded that the udic Inceptisols from the uplands of Puerto Rico can supply on the average 279 kg/ha of K during the first year, but the long term supplying power is around 100 kg/ha.yr.

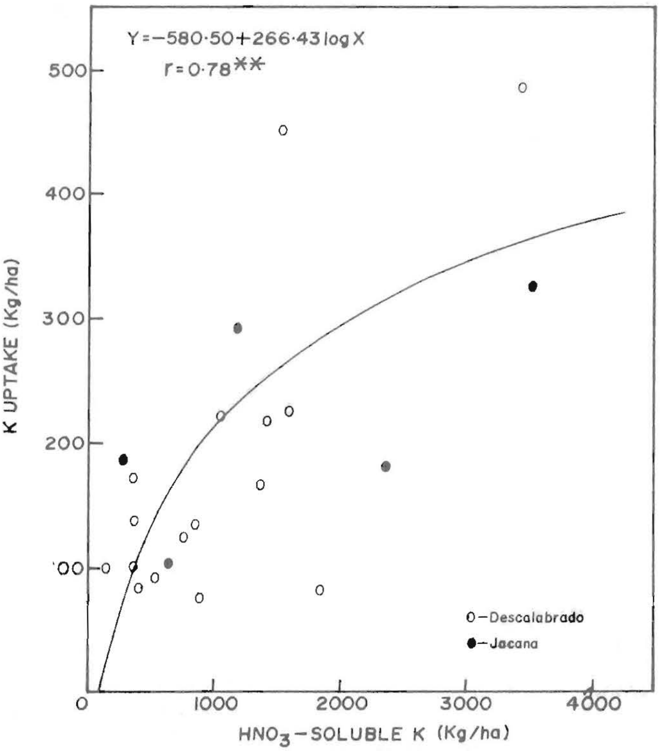

FIG. 8.—Relationship between the HNO_3 soluble K content of the most important Ustic Inceptisols of Puerto Rico and uptake of this nutrient by Pangola grass during the last 3 cropping years in pots.

The ustic Inceptisols, which are richer in K than the udic group can supply about 500 kg of K/ha during the first year and about 140 kg/ha.yr even after 4 years of continuous cropping.

RESUMEN

Se determinó la capacidad de los Inceptisoles de la altura de Puerto Rico para suplir K al pasto Pangola mediante un experimento en invernadero utilizando tiestos, y de cuatro experimentos de campo en suelos Múcara y Pandura.

El grupo Udic suplió en promedio 279 kg/ha de K al pasto el primer año y luego disminuyó a 110, 114 y 93 kg/ha en el segundo, tercero y cuarto años, respectivamente. El promedio de 106 kg/ha para los últimos 3 años parece ser un índice apropiado para estimar la capacidad de estos suelos para suplir K al pasto Pangola.

El grupo Ustic suplió en promedio 507 kg/ha de K el primer año. En los 3 años siguientes las cantidades fueron de 254, 233 y 140 kg/ha para el segundo, tercero y cuarto años, respectivamente. Aunque el promedio para los últimos 3 años fue de 209 kg/ha la continua disminucion en la cantidad de K extraída por el pasto, parece indicar que la capacidad de estos suelos para suplir K a largo plazo a las cosechas debe ser menor.

La cantidad de K que extrajo el pasto Pangola de los suelos Pandura y Múcara en el experimento en invernadero corresponde bastante fielmente con los valores obtenidos en los experimentos de campo.

El contenido en K cambiable del suelo al comienzo del experimento se correlacionó significativamente con la cantidad de este elemento nutritivo extraido por el pasto Pangola el primer año, mientras que el K soluble en ácido nítrico se correlacionó en forma significativa con la cantidad media de K extraida por el pasto en los últimos 3 años de experimentación.

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