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FACT SHEET

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PHOSPHORUS AND POTASSIUM FERTILIZATON FOR COASTAL BERMUDAGRASS HAY PRODUCTION IN EAST TEXAS

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Coastal bermudagrass has become the major hay crop in East Texas with an estimated 2 million acres produced in this area. Probably 30 to 40 percent is harvested for hay. With the continued removal of phosphorus (P) and potassium (K) by this deep rooted crop, the already nutrient-deficient soils are being further depleted as shown by soil test summary data in table 1. (Note that both P and K levels changed; phosphorous changed dramatically in 1979-80. However, this does not represent a trend in fertility status, but rather a change in extraction procedure.)

Results from studies conducted on Coastal bermudagrass at the Texas A&M Research and Extension Center at Overton between 1970 and 1976 are reported in table 2. Data show that the response to P increased during the first 4 years, even when no K was applied. However, during years five through seven, yields from the no K treatment were no better than the N-O-O plots.

The same data show an increase in response to K from the first to sixth year. Even though the response was not significant the first year, it was statistically significant the sixth year and shows the effects of depleting soil K. By 1975, helminthosporium, a leaf disease, had invaded the no K plots resulting in stunted growth and reduced yields.

Further study shows that rhizome production was reduced greatly in no K plots, which reduces the rate of recovery from winter dormancy and eventually causes stand losses.

In 1978 work conducted at Overton showed the effects of K on visual stand ratings and rhizome production (table 3). As K rates increased from 0 to 240 pounds per acre, visual stand rating percentage increased from 43 to 69 in the spring and from 17 to 88 in late summer. Rhizome production increased from 1,073 to 1,938 pounds per acre in the spring and from 112 to 1,540 pounds per acre in the fall as a result of K applications. Although the importance of rhizomes in regenerating spring growth is known, the influence of K fertilization on rhizome production has not been measured before this work. Research results in Arkansas show that spring cover is increased greatly by K applications.

Based on these developments, four demonstrations were initiated in 1976. The locations and treatments are listed in table 4. Two additional locations were added in 1978.

DEMONSTRATION PROCEDURE

Demonstrations were established to obtain yield response data from P and K, to correlate soil test results and to aid in developing fertilization practices for the East Texas region. The first increment of nitrogen, along with P and K, was applied in the early spring with an additional 100 pounds N after each cutting. Half of the K for treatment 5 was applied after the second cutting. Treatments were repeated annually on the same 1-acre plots. Fertilizer materials were obtained through the Tennessee Valley Authority program. The N source was usually urea, P was from ammonium phosphate and K was from potassium chloride. Hay bales were counted for each treatment to estimate yield, and bales were weighed to obtain an average. Where possible, the period between harvest was 30 days or less. Soil samples were collected before the initial application and once or twice during the demonstration period. In these demonstrations the primary variables were P and K and the main objective was to determine if a response was obtained from these nutrients. However, the most significant response rate cannot be determined.

RESULTS AND DISCUSSIONS

Response to Phosphorus

Response to P was not consistent among years and locations, thus confirming the idea that demonstration data should be collected for more than 1 year.

Years within location. The greatest response to P occurred during the first years. This was expected because soils tested low in P. The 100 pounds per acre, P_2O_5 application rate caused a build-up of soil P.

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The average response was 1,806 pounds per acre with a range from 246 pounds at the Read location to 3,075 pounds at the Branch location.

Coastal responded to P at the Pilgram farm in 1976 and 1977, but not in 1978, which was an extremely dry year (table 6). Total production in 1978 was only about half the average for the 3 years. Each year there were responses at the Branch farm (table 7) and Driskell farm (table 8). Average response at the Branch farm was over 1½ tons per acre. At this location, the response was greater during the third year than during the first year. Soil tests showed phosphorus increased from less than 1 part per million in the 0- to 3-inch layer to over 20 parts per million with P fertilization.

Between locations. There was no response at the Read farms location (table 10) and only a moderate response at the Davis location (table 9). Forage analysis showed an increase from .14 to .19 percent P resulting from the P application at the Davis location. At the Read location, P application showed no increase, which is consistent with yield data for 1978.

Because adequate P is necessary for high coastal production, there is a danger of depleting the soil to a deficient level without fertilization. If following the concept that soil levels be maintained at a medium or higher level, at least apply the P removed after soils have been "built up" to this level. Where soils test below medium, phosphorus fertilization should meet crop needs plus provide additional phosphorus to bring the soils up to a medium level within 2 or 3 years.

Response to Potassium

Response to K was not consistent among years at the same location, between locations and for the split K application. The initial level of soil K in the surface soil as well as subsoil influences the yield response from fertilization.

Years within location. Although there are inconsistencies between years, the response was greater and more frequent during the last year of the study. This is in agreement with research findings, which show that inadequate K under high N fertilization depletes the soil K and increases the magnitude of the yield response.

Between locations. Yields were higher at the Pilgram and Branch locations and showed responses of 24 and 14 percent, respectively, which would appear to be statistically significant. The average yield at the Driskell location was less and insignificant. The initial pH at this location was 5.4, which could have limited production. The initial surface and subsoil K levels were very low making a response predictable. It is apparent that K responses are associated with the production level affected by N and other production factors.

The 1978 and 1979 yield levels at the Davis and Read locations were comparable with those from the Pilgram and Branch locations. There was an apparent significant response at the Davis location for 1978 and 1979. Tissue concentrations of K in table 9 show the K in samples from the no K plots to be about one-third of that in the high K treatment plot.

The cooperator (table 10) followed a good fertilization program and no response to K was obtained in 1978 nor was plant content affected by K fertilization. But in 1979 a response began to show up. Concentrations for the Read location did not change in 1978 despite omitting K from the fertilizer, confirming that the soil level was adequate during the first year of the demonstration. In 1979 a response was evident. However, plant composition data were not available for this year.

An important question is how far can the soil K be "drawn down" by cropping at no or low K fertilization, and at what level should K be maintained? The predominant concept is to maintain a medium soil test level. Apply at least the K removal at this level. As illustrated by the Read location, omitting K for 1 year can decrease production. Therefore, under consistently high rates of N (400 to 600 pounds) there is an advantage to apply some K at the high medium or high levels.

Obviously, subsoil K is important and should be evaluated in developing long-range fertilization programs. Each farmer should collect enough subsoil samples to know if subsoils are generally low or high in K. Since these levels do not vary as much between fields and years, fewer samples are needed than for topsoils. High subsoil K accounts for a lack of response when surface soils are low in K.

Split applications. Dividing the K rate into two applications does not show a consistent advantage or disadvantage. The only location that showed slight but consistently higher yields from the split application was Pilgram's. Also yields were higher consistently at this location, again indicating that any advantage from split applications may be at high production levels.

It was noted that the 300 pounds per acre K_20 rate may be above the break in the response curve. Hence, this amount applied as a single application overcomes any improved efficiency from delaying part of the amount applied. Because of the application rate, do not interpret these data to show that circumstances do not exist under which split applications are desirable. Since weather conditions, especially moisture, are generally more favorable during the spring and early summer, apply potash before this period. Any delayed application should not risk inadequate K during the early growth period.

P/K Interaction

An interaction, either positive or negative, is encountered when the response of one or a series of factors is modified by one or more other factors. In these coastal demonstrations, there is a positive interaction between P and K fertilization.

Table 1. Soil test summary data for potassium in East Texas soils (from Extension Soil Testing Laboratory data).

Period of summary	Number of samples	Percent of samples testing									
		VL		L		M		H		VH	
		P	K	P	K	P	K	P	K	P	K
1962-64	5,581	55	14	21	40	16	30	5	9	3	8
1971-73	4,482	58	14	21	47	14	22	5	14	2	1
1979-81*	8,163	28	31	15	30	20	16	20	15	17	8

*Change from modification of extraction procedure.

Table 2. Potassium response and yield decline on Coastal bermudagrass (from John Matocha, formerly at Texas A&M Research and Extension Center, Overton).

Treatment lb/acre	1970	1971	1972	1973	1974	1975	1976	Average
N-0-0	10,041	5,885	13,612	13,690	10,945	9,263	11,669	10,730
N-280-0	10,878	9,388	15,239	14,376	8,760	8,906	11,333	11,269
N-0-240	10,794	6,582	13,639	15,433	12,064	11,445	16,553	12,358
N-280-240	11,627	10,087	17,518	16,074	12,061	12,589	18,563	14,074

Table 3. Visual stand ratings and rhizome production as influenced by K_2O rates (from T. M. Keisling, formerly at Texas A&M Research and Extension Center, Overton).

K_2O rate, lb/A	Visual stand ratings (%)		Rhizomes produced, lb/A	
	Spring*	Late summer**	Spring*	Fall*
0	43	17	1,073	112
120	73	59	1,797	172
240	69	88	1,938	1,540
LSD_{05}	11	9	680	898

*Darco soil
**Cuthbert soil

In table 5 the average response to P for location and years was 1,805 pounds per acre. The average response to K was 3,723; the combined response to P and K was 5,324. In terms of percentages, omitting P gave a 14 percent decrease, omitting K a 29 percent decrease and P and K together decreased yield 41 percent. At every location, the effects of P and K applied together were greater than when either one was applied alone.

Interactions do not have to be between or among fertilizer nutrients but rather within any combination of management practices, such as grazing and fertility, stocking rates, moisture, rotation, etc. A balanced management system where everything is optimum and done on time results in higher production.

Table 4. Location of demonstrations.

Counties	Cooperator	County Extension agent	Common treatment
Smith	Ray Branch	Jimmy McDaniel	1. 300-0-0
Houston	Monte Driskell	Billy Percival	2. 300-100-0
Camp	Hubert Pilgrim	Gene Lee	3. 300-0-300
			4. 300-100-300
Anderson	Gerald May*	Ray Huddleston	5. 300-100-300**

*Not included in demonstration results because only cooperated 1 year.
**Split — half in spring and half after second cutting.

Table 5. Average hay yields from K demonstrations in East Texas (lb/acre)*.

Treatment**	Hubert Pilgrim	Ray Branch	Monte Driskell	Cloyce Davis	Willis Read	Average
1. 300-0-0***	8,515	7,513	6,506	5,866	9,751	7,630
2. 300-100-0	11,260	11,577	8,314	5,839	9,254	9,231
3. 300-0-300	11,347	11,853	9,242	11,411	11,892	11,149
4. 300-100-300	14,123	15,027	10,348	13,122	12,148	12,954
5. 300-100-300****	15,042	14,508	9,773	13,364	12,172	12,972

*1976-78 for Pilgram, Branch and Driskell; 1978-79 for Davis and Read.
**N rate varied from 300 to 400 lb/acre applied in three or more applications.
***Was 0 in 1976 and omitted from average.
****Split — half in spring and half after second cutting.

Table 6. Coastal hay production demonstration — Hubert L. Pilgrim, Camp County (lb/acre).

Treatment	1976	1977	1978	Average
1. 300-0-0	9,875*	11,655	5,375	8,515
2. 300-100-0	14,143	14,334	5,294	11,260
3. 300-0-300	17,459	10,073	6,510	11,347
4. 300-100-300	17,214	16,008	9,146	14,123
5. 300-100-300**	18,095	17,049	9,983	15,042

*0-0-0 in 1976, omitted from average.

**Split — half in spring and half after second cutting.

Table 7. Coastal hay production demonstration — Ray Branch, Smith County (lb/acre).

Treatment	1976	1977	1978	Average
1. 300-0-0	4,960*	10,420	7,160	7,513
2. 300-100-0	13,925	11,790	9,015	11,577
3. 300-0-300	14,680	11,960	8,920	11,853
4. 300-100-300	16,525	16,650	11,905	15,027
5. 300-100-300**	17,155	15,775	10,595	14,508

*0-0-0 in 1976, omitted from average.

**Split — half in spring and half after second cutting.

Table 8. Coastal hay production demonstration — Monte Driskell, Houston County (lb/acre).

Treatment	1976	1977	1978	Average
1. 300-0-0	3,849*	8,058	4,940	6,500
2. 300-100-0	10,378	8,544	6,020	8,314
3. 300-10-300	12,115	9,631	5,940	9,242
4. 300-100-300	12,173	11,098	7,773	10,348
5. 300-100-300**	11,579	10,783	6,957	9,773

*0-0-0 in 1976, omitted from average.

**Split — half in spring and half after second cutting.

Table 9. Cloyce Davis, Trinity County 1978-79.

	Results for 1978				
Treatment	Yield*	Percent crude protein	Percent P	Percent K	1979 yield**
1. 300-0-0	8,225	11.8	.16	.61	3,507
2. 300-100-0	7,995	11.4	.17	.53	3,683
3. 300-0-300	10,825	10.2	.14	1.67	11,998
4. 300-100-300	12,122	10.3	.17	1.79	14,122
5. 300-100-300	11,267	10.6	.16	1.56	15,461

*Average of three to four cuttings.

**First cutting lost due to rain; no K plots stand lost after third cutting.

Table 10. Willis Read, Tyler County 1979*.

	Results for 1978				
Treatment	Yield	Percent protein	Percent P	Percent K	1979 yield
1. 300-0-0	10,262	13.6	.18	1.81	9,241
2. 300-100-0	10,292	14.1	.20	1.48	8,216
3. 300-0-300	11,665	13.3	.19	1.82	12,119
4. 300-100-300	11,715	13.1	.19	1.51	12,580
5. 300-100-300	11,543	13.5	.20	1.84	12,801

*Average of three cuttings.

SUMMARY AND CONCLUSIONS

During the 4-year period (1976-79) applying around 300 pounds N per acre produced an average of 5 to 7 tons of coastal hay per acre. Under this production level the following are evident:

- Most soils showed a response to P and K fertilization.
- The degree of response to K increased from the first to the last year of most demonstrations.
- The advantages of split applications of K may appear at rates below 300 pounds K_2O per acre.

Do not interpret the results from these demonstrations to mean that higher yields per acre are not possible. With good weed control, higher N fertilization and good moisture, 8 to 10 tons per acre can be expected during the best years. In these demonstrations fertilizer applications usually were delayed because of late shipment. In addition, there was no concentrated effort to control spring weeds. All of these factors contributed to below maximum yields in relation to fertilization.

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