Belleview - Perry Sprayfield
Plant Materials Adaptation Study

1998 Annual Report

USDA
Natural Resources Conservation Service
Plant Materials Center
Brooksville, Florida

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PLANT MATERIALS ADAPTATION STUDY

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In Cooperation With

Marion Soil and Water Conservation District

and

The City of Ocala, FL

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INTRODUCTION

The state of Florida is undergoing a period of tremendous urban expansion. This has meant city managers must find methods of disposing of extended quantities of municipal wastewater. The practice of disposing of secondary municipal wastewater by land application (referred to as a sprayfield) is expanding rapidly. Initially, it was thought that this practice would provide great agronomic benefits, while disposing of thousands of gallons of domestic wastewater in a manner which would sustain groundwater quality. Instead, researchers and sprayfield managers have been faced with unique problems and challenges, and are searching for plant materials that can help to solve these problems.

Extremely large volumes of effluent water continuously applied cause the most serious problems associated with sprayfields. Generally, this effluent water has been purified until it contains only low levels of nutrients beneficial for plant growth. However, nondesirable minerals such as sodium, boron and magnesium are present, and can build up to toxic levels or leach into the groundwater if they are not removed by living filters. Effluent irrigation is often applied at a rate that rapidly leaches nutrients beyond rooting depth. This problem is further compounded by the nature of the sandy soils on which most sprayfields in Florida are located. Coarse soils do have the ability to filter large quantities of water without ponding. However, sorbtion capacity is minimal, creating an environment low in fertility. These factors also cause serious problems with weed competition.

The purpose of this study is to identify plant materials that are adaptable to the sprayfield environment. They must be quick to establish, able to tolerate excessive irrigation and low fertility, and competitive with invading weed species. These plant materials must provide maximum uptake of effluent nutrients and be commercially marketable as well. Because sprayfields need to stay in operation throughout the year, selected species should also provide water uptake singly or in rotation with other species throughout the entire year.

LITERATURE REVIEW

The primary goal of a sprayfield is to recycle large volumes of wastewater and associated nutrients without negatively impacting the environment, especially in terms of water quality. A secondary goal is to produce commercially marketable crops that use the maximum amount of effluent water and nutrients (Roberts and Vidak, 1994). The use of sprayfields to process secondary effluent is a relatively new practice for most municipalities in Florida, and associated research is minimal. High rainfall, a long growing season, and highly leachable coarse soils make sprayfield operations in Florida unique from those in other areas. Also, domestic water use may actually increase in Florida during the winter months, due to tourism and return of winter residents. Sprayfields must continue disposing of effluent wastewater during the winter months, even though many crop and forage species are dormant at this time. Forage grasses such as Coastal bermudagrass, used in rotation with winter rye, are reported as being among the most desirable sprayfield crops, because they can tolerate excessive water application and have high nutrient use (Vidak and Roberts, 1991; Kardos and Sopper, 1973). In addition, they require less management and fewer inputs than more intensive row crop rotations.

Since the inception of sprayfields, plant managers have found ways to decrease the amount of nitrogen in effluent water. This has created an environment low in fertility. Also, many nutrients are quickly leached past the rooting zone by heavy effluent application rates, and excessive rainfall. Results from research conducted at a Tallahassee, Florida sprayfield showed that application of nitrogen, potassium, sulfur and trace minerals is necessary for maintaining crop production. Calcium ions from effluent water appear to displace other nutrients, further enhancing deficiencies, especially in the micronutrients. However crops could not be managed according to standard production guidelines because of greater potential for nutrient leaching (Vidak and Roberts, 1991; Overman, 1979). The phosphorus in the effluent water appears to be of adequate quantity to meet crop needs, being sorbed to soil particles within the rooting zone (Flaig, Mansell, and Yuan, 1986).

Although sprayfields can apply almost unlimited amounts of water to a field, application rates are limited by the crop's ability to efficiently recover nitrogen. Research results using ryegrass, bermudagrass and other forages, show best nitrogen recovery efficiency occurred at approximately 2 inches per week, applied at an intensity of no greater than 0.5 in/hr (Overman, 1979; Overman and Ku, 1976, Kardos and Sopper, 1973). Another management practice which can be employed is to withhold water at certain stages of crop growth in order to encourage the development of more extensive rooting systems, thus promoting greater nutrient uptake (Roberts and Vidak, 1994). Due to high irrigation and precipitation, weeds flourish in the sprayfield environment. Despite earlier thoughts to the contrary, results of recent research confirm that fertility and weed management is necessary for maximum efficiency of a sprayfield operation.

PREVIOUS WORK BY THE FLORIDA PMC

During 1990 through 1993, the City of Ocala provided the FLPMC a plant adaptation study site at the Pine Oaks Golf Course effluent disposal site. A large variety of grasses and forbs were planted and evaluated for performance and nutrient uptake. However, high pressure rotating guns were used to water this site, and application rates were not consistent. In 1993, a study site was developed at the Perry Reuse facility, near Belleview (henceforth referred to as the Belleview Sprayfield). This site is watered by an overhead sprinkler system, which is controlled independently from the main center pivot sprinkler systems. In 1994, a broad range of grasses and forbs were planted and evaluated. Results from this early work were analyzed. Species which showed the greatest capacity for adaptation and nutrient removal, as well as having high commercial value, were selected for more intensive study.

MATERIALS AND METHODS

In 1995, all plant materials from previous studies were removed from the research site at the Belleview Sprayfield, in preparation for establishment of the current study in 1996. Millet was planted on the entire field in the summer of 1995, to take up any residual nitrogen left from legume plots. The millet residue was removed from the field in the fall of 1995.

The plant materials selected for this study were ‘Coastal’ bermudagrass (*Cynodon dactylon*);‘Pensacola’ bahiagrass (*Paspalum notatum*); Eastern gamagrass (*Tripsacum dactyloides*), FLPMC accession no. 9055975; ‘Alamo’ switchgrass (*Panicum virgatum*); ‘Defuniak Source’ switchgrass (*Panicum virgatum*), PMC accession no. 9059616; ‘Floralta’ limpograss (*Hermarthria altissima*); ‘Mott’ dwarf elephantgrass (*Pennisetum purpureum*); and ‘Sharp’ marshhay cordgrass (*Spartina patens*). ‘Florigraze’ perennial peanut (*Arachis glabrata*) was also included in this study because of its ability to fix nitrogen. Since the sprayfield environment is actually low in nitrogen, a sustainable, slow release form of nitrogen such as that produced by perennial peanut may be preferable to applying chemical fertilizers. Bermudagrass and bahiagrass were included as standards, since they are so widely used in Florida. Due to the climate and the predominate livestock-base of the local agriculture economy, only forage grasses and legumes were used in this study.

All species were established in six-inch deep cone tubeling trays, and placed in the shadehouse at the FLPMC (except for gamagrass, which was established in pots which were six inches wide and deep). Plants were pre-established in the shadehouse so that all species would be placed in the field at the same stage of growth. Both switchgrasses and bahiagrass were established in the conetainers using seed. The other six species were established in conetainers from plant propagules.

In April of 1996, seven grass species were planted in the field. The winter of ‘95-‘96 was relatively cold, with several killing frosts. This caused the plant materials in the FLPMC shadehouse to become dormant. The peanut and ‘Defuniak Source’ switchgrass had not recovered sufficiently for planting in April. Therefore, these two species were not planted in the field until July of 1996. Weeds were controlled in all plots in 1996 and 1997, by hand weeding and with chemical herbicides.

The ‘Sharp’ marshhay cordgrass had not established well in the field by 1997, so maidencane (*Panicum hemitomon*), PMC accession no. 421993, was established on half of the ‘Sharp’ plots in the summer of 1997, to better utilize the space. Although maidencane will not be analyzed with the other species, information will be gathered on the adaptability of this wetland native grass species to a sprayfield environment. The maidencane was established by placing vegetative material in shallow trenches.

The climate at the research site is warm and humid, with 55 inches average annual precip. and an average growing season of 260 days. Soils are predominately sand and sandy loam (Candler sand). The water table is six feet deep or more. Soil samples were taken before initial establishment, and once a year in each plot at 0-6”, 6-12”, 12-24”, 24-36” increments. Samples were sent to a soils testing facility to determine presence of NO3-N, NH4-N, P, K, Ca, Mg, Fe, Mn, B, Cu, Zn, Na and Al.

Plots are 34'x 34' in size, in a randomized complete block design with four reps per treatment (except 'Sharp' and maidencane plots, which are 14'x 34'). Effluent water was applied approximately three times a week, depending on rainfall. The management goal was to irrigate the site throughout the growing season so that combined rainfall and irrigation was approximately 2 inches per week.

Tissue samples were taken approximately every 45 days beginning in late April or early May. The exception to this was switchgrass. They were clipped more often in an effort to slow growing point extension in the stems. Once the growing point extended beyond 14 inches, clipping ceased. Clipping below the growth point removes too much leaf tissue, which stresses the plant and rapidly decreases stand density. The tissue samples were taken with a 3 foot wide Carter forage plot harvester.

Tissue samples were weighed wet, a grab sample taken, weighed, dried, weighed again, ground and sent in to a tissue analysis facility for testing (TKN, P, K, Ca, Mg, Na, Fe, Zn, Al, B, Cu). All material from plots was clipped and removed at each sampling date.

Clipping heights were 2-4 inches for peanut, bahiagrass and bermudagrass; 6 inches for limpograss; 8 inches for maidencane, marshhay cordgrass, eastern gamagrass, switchgrass, and dwarf elephant grass. Switchgrass clipping heights increased with the extension of the growing point to 14 inches. The length of this study is scheduled to be four years, including establishment year.

The MSTATC (Michigan State Univ., 1988) statistical package was used to conduct analysis of variance (ANOVA) on dry matter yields of each species. Comparisons were made between means using Tukey's Honestly Significantly Different test at a significance level of $P<0.05$.

Harvesting 'Mott' Dwarf Elephantgrass

RESULTS AND DISCUSSION

ESTABLISHMENT

All grass species except ‘Sharp’ marshhay cordgrass established well in 1996. The perennial peanut was slower to establish and did not provide complete canopy cover in the plots until the 1997 growing season. Because the switchgrasses and gamagrass have a bunch-type growth habit, weeds tend to grow between the plants, even after they are well established. Weed competition was fairly severe in all species in 1996. Weeds were controlled through an intensive hand weeding and herbicide application program. By the 1997 growing season, most species except ‘Sharp’ were established well enough to suppress weed competition. However, herbicide weed control was still conducted on most plots, to suppress weeds completely. ‘Mott’ dwarf elephantgrass had developed such a dense canopy by the 1997 growing season, that all weed competition was suppressed by the plants, negating the use of chemical herbicides.

Plants were allowed to grow without clipping in 1996. Winter frosts caused all species to go dormant during the winter. In March of 1997 all plots were mowed to the designated height. Excess residue was then removed by burning. ‘Defuniak Source’ switchgrass, peanut and ‘Sharp’ plots did not have enough residue to require burning. Plots were harvested during the 1997 growing season as outlined above.

The winter of 1998 was very warm, and most species at the Belleview site did not go completely dormant. Excess top growth was clipped and removed instead of burned in February of 1998, because there was too much green material on most plots, which would have inhibited burning.

Table 1. Inches of moisture received per month at the Belleview study site in 1997, including precipitation, irrigation and the combined total.

Month	Precip. (inches)	Irr. (inches)	Total (inches)
January	2.00	0	2.00
February	0	2.64	2.64
March	2.75	4.8	7.55
April	3.75	7.00	10.75
May	2.70	7.20	9.90
June	4.90	4.82	9.72
July	3.50	12.02	15.52
August	3.50	7.44	10.94
September	1.75	7.36	9.11
October	0	5.52	5.52
November	4.50	0	4.50
December	10.50	0	10.50

PRECIPITATION AND IRRIGATION

The quantity of effluent water and precipitation the study site received monthly during the 1997 growing season is shown in Table 1. The primary growing season for most species began in March and ended in October. The irrigation meter was read every two to three weeks, so application rates were averaged across the given time period. The goal was for the study site to receive a total of 2 inches of moisture weekly, through both irrigation and precipitation. Due to the coarse nature of the soils at this site, applying less than two inches of water appeared to cause plants to undergo drought stress.

Table 2 shows the irrigation and precipitation amounts received on the study site in 1998. The irrigation amounts applied to the study site were not consistent, due to change of personnel operating the system. More irrigation water was applied during several months in 1998 than the plants were capable of using efficiently.

Table 2. Inches of moisture received per month at the Belleview study site in 1998, including precipitation, irrigation and the combined total.

Month	Precip. (inches)	Irr. (inches)	Total (inches)
January	4.00	0.00	4.00
February	8.75	0.00	8.75
March	3.25	0.06	3.31
April	1.50	9.69	11.19
May**	1.75	10.32	12.07
June**		5.65	5.65
July**	2.00	3.90	5.90
August	4.25	27.25	31.50
September	18.50	5.93	24.43
October	1.50	10.37	11.87
November	2.00	10.37	12.37
December	1.25	10.37	11.62

**Missing rainfall data

SOIL SAMPLING

Initial soil samples were taken in 1993, 1994 and 1996 from the study site. Soil samples were analyzed by Micro-Macro International, Inc. in Athens, GA. Tests were conducted according to the procedures outlined in “Handbook on Reference Methods for Soil Analysis”, 1992, by the Soil and Plant Analysis Council, Inc., Athens, GA. Mehlich No. 3 was the extractant used for the mineral elements, according to Mehlich (1981). In Appendix A, Table 12 displays the ranges of nutrients in the soil in reference to plant needs. When the study began in 1996 soil sample test results showed that phosphorous present at the study site was in the high range, and potassium was in the low range for plant requirements (Table 13). The micro nutrients calcium and magnesium were also in the low range (Table 14). Nitrate levels were also tested, and were fairly high in the lower profiles. However, nitrates are highly susceptible to leaching in coarse soils, and fluctuate too rapidly to be followed through soil testing.

Soil samples were taken from each plot in 1997 and 1998, at the beginning of the growing season. Results are shown in Tables 16 through 25 in Appendix A. In comparing 1997 with 1996 soil samples, both P and K had generally doubled in the upper six inches of the soil profile in most plots, placing phosphorous in the very high range for plant needs. Potassium was still in the lower levels for plant requirements (Tables 16 & 19). Calcium and magnesium had increased three to four times in the upper six inches over 1996 sample levels, but were still within the low range generally. The pH levels at the soil surface had increased slightly in the upper six inches in most plots. (Average in 1996 samples was 4.4. Average in 1997 samples was 5.0.) This was due in part to the increased calcium levels, however, pH ranges were still very acidic. Calcium, magnesium, phosphorous, boron and potassium are most available at a pH of 6 or greater. Nitrogen, copper and zinc are most available at a pH of 5.5 or greater. However, the more acidic the soil, the more available iron, aluminum and manganese are, to the point of causing toxicity problems in plants. Of the nondesirable minerals, sodium had generally tripled in the upper six inches in most plots. In the 1997 samples, boron actually decreased in all but two plots over ‘96 sample levels. The upper six inches of the limpograss and ‘Defuniak Source’ switchgrass plots had substantially higher levels of boron than did the other seven species in 1997 samples. Levels of aluminum had increased dramatically between 1993 and 1996. However, aluminum levels at all depths were generally static between 1996 and 1997.

Soil samples taken in 1998 reflected uptake from the 1997 growing season. P decreased substantially, dropping 50 to 70% from beginning 1997 levels (Table 19 and 23). Surface levels did not diminish as greatly, which indicates that most species were mining nutrients up to 36” below the soil surface. K actually increased under several species at given depths, though overall levels were still in the low range. Surface Ca levels increased under all but gamagrass, bahiagrass and ‘Alamo’ swithchgrass, into the medium level (Table 24). This is also reflected in the increased pH on the surface of many plots. All other nutrients generally decreased under most species. This was true of undesirable nutrients such as Na and Al as well (Table 25).

It appears that the effluent water provided adequate nutrients to meet plant requirements during the first three years of this study. Soil samples will continued to be taken on a yearly basis to chart the presence of the less leachable macro and micro nutrients.

TISSUE SAMPLING

Total Dry Matter Production

In 1997, most species were harvested on four occasions, covering a growing period of 169 days. Clippings occurred on roughly a 45 day schedule. ‘Alamo’ switchgrass was clipped on four occasions before tiller growth points extended beyond 14 inches. ‘Defuniak Source’ switchgrass was slower to mature, and could therefore be clipped on five occasions. The switchgrasses were clipped more frequently in an attempt to keep the growing points in the stems from extending too fast. ‘Sharp’ did not recover well from the second clipping. Therefore, it was allowed to grow without disturbance for the remainder of the growing season.

Total 1997 dry matter production for each species is shown in Table 3. ‘Mott’ dwarf elephantgrass had the greatest production (10,489 lbs./ac.) in 1997. Bermudagrass, one of the standards of comparison in this study, had second greatest dry matter production (8785 lbs./ac). Total limpograss production was only 1000 pounds less than that of bermudagrass, not a significant difference. Bahiagrass, eastern gamagrass and perennial peanut all produced approx. half the amount of forage that ‘Mott’ produced. Dry matter production of the switchgrasses was similar for the two different varieties, however levels were only approx. a quarter of the amount produced by ‘Mott’.

The percentage of total dry matter obtained at each cutting date in 1997 is also shown in Table 3. It is interesting to note that for bermudagrass, bahiagrass and peanut, almost half of the total dry matter was harvest on the last clipping date (Aug. 19). ‘Mott’ and gamagrass dry matter production levels were fairly evenly distributed across the three last clipping dates for these species. The switchgrass began growing earlier than the other species. However, both species had produced seedheads by July 9, and forage production had ceased.

Table 3. Percent of total dry matter production per clipping date for nine species grown at the Belleview sprayfield in 1997, based on 169 day growing period.

	Total DM	**% of Total Dry Matter Production per Cutting Date**						
Species	lbs/ac	3/27	4/22	5/8	5/28	6/17	7/9	8/19
Mott	10,489*a**		14		23		34	30
Bermuda	8,785*b*		13		18		21	48
Limpograss	7,812*b*		10		16		33	41
Bahia	5,356*c*		6		27		22	44
Gama	5,356*c*		12		28		37	24
Peanut	5,072*c*		4		10		30	56
Alamo	2,492*d*	15	33	15	37			
Defuniak	2,144*de*	5	10	7	23	29	27	
Sharp	786*e*		23		77			
Mean	5,365							
LSD (0.05)	907							

*Total DM amounts followed by the same letter are not significantly different according to Tukey’s HSD at P<0.05.

In 1998, all species except the two switchgrasses were harvested four times. Harvest frequency was roughly every 45 days. The growing season in 1998 extended to 208 days. Therefore, total dry matter yields are listed in Table 4 for both a 208 day growing season and a 166 day growing season, so comparisons could be made with 1997 totals. Most species had substantial regrowth by the 9/23/98 clipping date. However, army worms had severely infested several of the plots. ‘Mott’ and bermudagrass were the hardest hit, with an estimated one-third to one-half of the top growth having been removed by the voracious pests. Both switchgrass species had completed seed production and gone dormant by the last clipping date. Therefore, these two species were also harvested to a height of 14”. The switchgrasses, especially ‘Alamo’, had produced a substantial amount of forage (12,249 lbs./ac.) by September. When compared to the other species in this trial, however, switchgrass forage quality is very poor after seed set.

Yields increased in 1998 from 1997 levels. This was most likely do to the heavier application of effluent water in 1998. Based on a 208 day growing season, bermudagrass had the greatest total dry matter yield in 1998 (14,247 lbs./ac.). This amount was not statistically different than the total dry matter yields for ‘Mott’, limpograss, peanut or ‘Alamo’. Two of the gamagrass plots had severe stand losses during the 1998 growing season, and many of the plants in those plots died or were doing poorly. Dry matter yields on these two plots was only 30% of the total yield obtained on the other two plots, which substantially reduced total yield for this species. The cause was unknown.

Table 4. Total dry matter production per clipping date for nine species grown at the Belleview sprayfield in 1998, based on 169 and 208 day growing period.

	Total DM (lbs/ac)	
Species	**166 days**	**208 days**
Bermuda	12,131*a*	14,247*a**
Mott	12,650*a*	13,866*ab*
Limpograss	11,779*ab*	13,311*ab*
Peanut	10,421*ab*	12,626*ab*
Bahia	9,185*bc*	10,597*bc*
Gama	7,365*cd*	8,358*c*
Alamo	2,621*e*	12,249*ab*
Defuniak	2,860*e*	7,371*c*
Sharp	5,807*d*	7,305*c*
Mean	8,313	11,103
LSD (0.05)	1,718	2,188

*Total DM amounts followed by the same letter are not significantly different according to Tukey’s HSD at $P<0.05$.

Percent of total dry matter obtained at each cutting in 1998 is shown in Table 5. Almost half of all production occurred in August for all of the species. This information would be useful for sprayfield managers who wanted to increase or decrease application rates according to the growth curve of the species under cultivation. Coordinating application rates with growth rates would minimize nutrient leaching below the root zone.

Table 5. Percent of total dry matter production per clipping date for nine forage species grown at the Belleview sprayfield in 1998, based on 208 day growing period.

	Percent of 208 Day Total DM

Species	4/16	4/29	5/19	6/17	8/12	9/23
Bermuda		10		32	44	15
Mott		6		38	48	9
Limpograss		2		42	44	12
Peanut		10		29	44	17
Bahia		5		34	48	13
Gama		17		31	41	12
Alamo	10	4	8			79
Defuniak	3	3	10	22		61
Sharp		5		19	56	21

Macro and Micro Nutrient Uptake

Tissue testing was conducted by Micro-Macro International, Inc. Tests were conducted according to procedures presented by Jones (1977). Total pounds per acre of nitrogen, phosphorous and potassium harvested in 1997 are shown in Table 6. Because of higher dry matter production, 'Mott' had the greatest nitrogen uptake (270 lbs./ac.). The nine species ranked the same in total N harvested as they did for dry matter production.

Table 6. Pounds per acre of total N, P and K harvested in nine species grown at the Belleview sprayfield in 1997.

Species	Total N	P	K
	lbs/ac		
Mott	270	52	495
Bermuda	219	28	168
Limpograss	187	27	176
Bahia	134	18	106
Gama	135	17	95
Peanut	125	19	120
Alamo	68	9	61
Defuniak	59	9	44
Sharp	19	2	12

'Mott' had the greatest phosphorous uptake of any of the nine species (52 lbs./ac.) in 1997. Bermuda and limpograss each had approx. half of the P uptake that 'Mott' had. Peanuts, bahia and gamagrass had approx. one third of the P uptake of 'Mott'. The switchgrasses had approx. a fifth of the P uptake of 'Mott'.

Of the nine species, 'Mott' had by far the greatest potassium use (495 lbs./ac.) in 1997. Bermuda and limpograss had approx. one third, and peanut and bahiagrass had approx. one quarter of the total K use that 'Mott' did. Pounds per acre of K harvested from gamagrass plots was only 19% of 'Mott' levels while 'Alamo' and 'Defuniak

Source' totals were 12% and 8% of 'Mott' totals respectively. 'Mott' appears to be a tremendous user of K. Supplemental amounts of K may need to be applied to 'Mott' fields if effluent water does not supply enough of this nutrient to sustain optimum forage production.

Table 7. Pounds per acre of N, P and K obtained through June 19 in nine species grown at the Belleview sprayfield in 1998.

Species	Total N	P	K
	lbs/ac		
Mott	227	19	185
Bermuda	217	15	75
Limpograss	208	15	100
Peanut	178	16	96
Bahia	154	9	56
Gama	151	11	56
Alamo	100	9	55
Defuniak	109	10	47
Sharp	62	4	18

Table 8. Pounds per acre of Ca, Mg, Fe and Na harvested in nine species grown at the Belleview sprayfield in 1997.

Species	Ca	Mg	Fe	Na
	lbs/ac			
Mott	53	24.0	1.4	9.5
Bermuda	44	13.7	1.3	6.6
Limpograss	24	20.2	0.7	15.3
Peanut	87	31.9	1.2	3.7
Bahia	29	14.9	1.0	5.8
Gama	14	7.5	0.6	24.7
Alamo	9	8.3	0.3	3.9
Defuniak	5	4.3	0.2	4.7
Sharp	5	1.8	0.1	6.8

Due to severe budget cuts, funds were not available for analysis of all the tissue samples collected in 1998. Samples from the last two harvests have yet to be analyzed. Therefore, total pounds/acre of N, P and K obtain through 6/19/98 only are shown in Table 7. Trends were the same as those seen in 1997, with 'Mott' exceeding all other species in N and P uptake. It is interesting to note that many species had almost reached 1997 uptake levels by 6/19/98. 'Mott' once again took up substantially larger amounts of K than the other species did.

Pounds per acre of calcium, magnesium, sodium and iron harvested in 1997 are shown in Table 8. The greatest amount of calcium uptake occurred in perennial peanut (87 lbs./ac.), despite the fact that it ranked sixth in dry matter production. 'Mott' and bermudagrass had roughly half, limpograss and bahiagrass had roughly a third of the Ca uptake that peanut did. Peanut also had the greatest magnesium uptake. Greatest sodium uptake occurred in gamagrass (24.7 lbs./ac.). Limpograss had the second highest sodium uptake (15.3 lbs./ac.). However, when considered as a percentage of dry matter, 'Sharp' had the highest sodium content (0.87%), and gamagrass was second highest (0.46%).

Table 9. Pounds per acre of Ca, Mg, Fe and Na obtained through June 19, in nine species grown at the Belleview sprayfield in 1998.

Species	Ca	Mg	Fe	Na
	lbs/ac			
Mott	21.9	7.5	0.73	4.4
Bermuda	18.6	5.1	0.57	3.9
Limpograss	14.3	11.5	0.42	10.4
Peanut	58.5	22.4	0.96	4.9
Bahia	14.3	6.8	0.56	4.7
Gama	6.7	3.2	0.33	16.5
Alamo	9.0	6.7	0.34	3.6
Defuniak	6.9	4.7	0.35	8.4
Sharp	6.6	2.5	0.12	18.1

Pounds per acre of calcium, magnesium, sodium and iron harvested in 1998 through 6/19 are shown in Table 9. Uptake trends were the same as occurred in 1997.

Table 10. Pounds per acre of Al, B, Cu and Zn harvested in nine species grown at the Belleview sprayfield in 1997.

Species	Al	B	Cu	Zn
	lbs/ac			
Mott	1.2	0.09	0.07	0.30
Bermuda	4.1	0.05	0.03	0.23
Limpograss	1.1	0.06	0.05	0.19
Bahia	2.4	0.05	0.02	0.17
Gama	0.7	0.06	0.03	0.12
Peanut	3.9	0.25	0.03	0.20
Alamo	0.2	0.02	0.02	0.06
Defuniak	0.2	0.03	0.02	0.05
Sharp	0.3	0.01	0.00	0.01

Pounds per acre of aluminum, boron, copper and zinc harvested in 1997 are shown in Table 10. The greatest amount of aluminum uptake occurred in bermudagrass

(4.1 lbs./ac.). Second highest was in perennial peanut (3.9 lbs./ac). Peanut was the highest user of boron (0.25 lbs./ac.)

Pounds per acre of aluminum, boron, copper and zinc harvested through June 19 of 1998 are shown in Table 11. Perennial peanut had the highest aluminum and boron uptake to this point.

Table 11. Pounds per acre of Al, B, Cu and Zn obtained through June 19 in nine species grown at the Belleview sprayfield in 1998.

Species	Al	B	Cu	Zn
	lbs/ac			
Mott	1.33	0.03	0.03	0.12
Bermuda	1.39	0.03	0.02	0.10
Limpograss	0.57	0.04	0.03	0.09
Peanut	2.93	0.25	0.02	0.14
Bahia	1.67	0.03	0.02	0.09
Gama	0.39	0.05	0.02	0.07
Alamo	0.21	0.01	0.02	0.06
Defuniak	0.22	0.02	0.02	0.06
Sharp	0.17	0.01	0.00	0.02

Maidencane plots were sampled on the last two clippings of 1998, to produce a total yield of 5,495 lbs./ac. of dry matter.

CONCLUSIONS

Since all the 1998 tissue samples are not yet analyzed, it is difficult to make any firm conclusions concerning nutrient uptake. Bermuda, ‘Mott’ dwarf elephantgrass and limpograss had the highest forage production of the nine species under study. ‘Mott’ thus far appears to have the greatest N, P and K uptake of the nine species. Once established, ‘Mott’ required virtually no weed control. Its dense canopy successfully shaded out most weed competition. All other species required some form of weed control once established, whether mechanical or chemical.

Tissue sampling is scheduled to continue for one more year, to study persistence of stand and consistency of performance.

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APPENDIX A

Table 12. Ranges of the nutrients phosphorous, potassium, calcium and magnesium in soils. Ranked according to plant availability in terms of pounds per acre (Mehlich, 1981).

Cation	Low	Medium	High
	lbs/ac		
P	0-30	31-90	90+
K	0-100	101-140	141-280
Ca	0-800	801-1600	1600+
Mg	0-200	201-280	281-480

Table 13. Soil pH, and lbs./ac. nitrogen, phosphorous and potassium per sampled depth from samples taken at the Belleview sprayfield in 1993, 1994 and 1996.

	Depth (inches)	pH	NH4 (lb/ac)	NO3 (lb/ac)	P (lb/ac)	K (lb/ac)
1993 Samples	0-4	4.4	1.2	5	49	55
	4-12	4.3	0.0	7	20	22
	24-30	4.4	0.0	7	12	17
1994 Samples	0-4	4.8	0.0	13	109	46
	4-12	4.8	10.8	0	184	63
	24-30	4.9	3.9	0	14	23
1996 Samples	0-6	4.4	0.1	12	97	28
(Avg. of 6 plots)	6-12	4.5	0.0	12	77	23
	12-24	4.3	0.8	24	135	37
	24-36	4.2	1.4	24	154	46

Table 14. Average pounds per acre of Ca, Mg, Na and Fe per sampled depth from soil samples taken at the Belleview sprayfield in 1993, 1994 and 1996.

	Depth (inches)	Ca (lbs/ac)	Mg (lbs/ac)	Na (lbs/ac)	Fe (lbs/ac)
1993 Samples	0-4	382	77	16	30
	4-12	201	26	16	19
	24-30	117	16	16	18
1994 Samples	0-4	963	145	75	13
	4-12	820	109	49	19
	24-30	294	53	29	14
1996 Samples	0-6	181	21	20	110
(Avg. of 6 plots)	6-12	121	16	19	116
	12-24	108	22	36	238
	24-36	231	32	38	198

Table 15. Average pounds per acre of Aluminum, Boron, Copper and Zn per sampled depth from soil samples taken at the Belleview sprayfield in 1993, 1994 and 1996.

	Depth (inches)	Al (lbs/ac)	B (lbs/ac)	Cu (lbs/ac)	Zn (lbs/ac)
1993 Samples	0-4	417	0.10	0.84	2.70
	4-12	449	0.06	0.36	1.76
	24-30	305	0.04	0.20	0.80
1994 Samples	0-4	412	0.92	0.52	2.66
	4-12	552	0.58	0.84	1.32
	24-30	322	0.28	0.46	0.24
1996 Samples	0-6	1153	1.34	1.67	0.94
(Avg. of 6 plots)	6-12	1124	0.83	1.37	0.57
	12-24	2142	1.62	2.06	0.58
	24-36	1976	1.38	0.90	1.29

Table 16. Soil pH, and lbs./ac. nitrogen, phosphorous and potassium per sampled depth. Numbers are averages of 4 reps per depth, taken at the Belleview sprayfield in 1997.

Species	Depth	pH	NH4	NO3	P	K
			lbs/ac			
Bahia	0-6	5.1	0.00	12	222	71
	6-12	4.7	0.00	13	131	39
	12-24	4.4	0.81	25	136	64
	24-36	4.4	0.00	24	134	48
Gama	0-6	5.0	0.00	13	194	74
	6-12	4.4	0.00	12	123	23
	12-24	4.2	1.58	24	127	40
	24-36	4.4	0.00	25	132	39
Alamo	0-6	5.1	0.00	12	212	54
	6-12	4.5	0.00	12	98	30
	12-24	4.3	2.11	24	165	40
	24-36	4.4	0.00	24	136	24
Sharp	0-6	5.2	0.00	13	212	54
	6-12	4.5	0.00	12	99	34
	12-24	4.4	0.00	24	129	53
	24-36	4.4	0.00	23	129	48
Bermuda	0-6	4.9	0.24	12	212	77
	6-12	4.5	0.00	12	152	56
	12-24	4.3	0.00	24	139	51
	24-36	4.5	0.00	24	156	47
Peanut	0-6	5.0	0.00	13	266	51
	6-12	4.5	0.00	13	164	33
	12-24	4.6	0.00	24	167	42
	24-36	4.3	0.00	24	144	34
Limpograss	0-6	4.8	0.00	12	231	82
	6-12	4.3	0.00	12	125	27
	12-24	4.2	0.00	24	117	48
	24-36	4.2	0.00	24	141	45
Defuniak	0-6	4.8	0.00	12	228	60
	6-12	4.3	0.00	12	95	28
	12-24	4.5	2.48	23	124	41
	24-36	4.6	0.24	25	132	38
Mott	0-6	4.9	0.00	13	209	74
	6-12	4.4	0.16	12	79	35
	12-24	4.3	0.00	24	133	13
	24-36	4.2	0.00	26	113	18

Table 17. Soil lbs./ac. of calcium, magnesium, sodium and iron per sampled depth. Numbers are averages of 4 reps per depth, taken at the Belleview sprayfield in 1997.

Species	Depth	Ca	Mg	Na	Fe
		lbs/ac			
Bahia	0-6	763	91	67	118
	6-12	287	32	43	106
	12-24	275	46	64	230
	24-36	187	36	53	276
Gama	0-6	735	107	92	119
	6-12	268	37	64	110
	12-24	148	33	68	266
	24-36	127	27	62	283
Alamo	0-6	681	95	60	115
	6-12	161	21	37	109
	12-24	117	25	48	244
	24-36	93	23	41	246
Sharp	0-6	651	82	55	102
	6-12	174	21	30	90
	12-24	162	32	48	227
	24-36	108	24	46	241
Bermuda	0-6	652	76	46	110
	6-12	293	36	38	117
	12-24	109	23	44	281
	24-36	121	23	40	288
Peanut	0-6	776	94	67	137
	6-12	300	38	48	121
	12-24	242	42	53	259
	24-36	126	25	47	250
Limpograss	0-6	875	110	64	133
	6-12	214	24	39	126
	12-24	155	28	50	229
	24-36	158	32	54	296
Defuniak	0-6	723	85	59	113
	6-12	175	22	36	97
	12-24	142	26	52	251
	24-36	125	25	47	257
Mott	0-6	806	107	78	115
	6-12	227	29	57	90
	12-24	150	27	74	251
	24-36	102	23	59	258

Table 18. Soil lbs./ac. of aluminum, boron, copper and zinc per sampled depth. Numbers are averages of 4 reps per depth, taken at the Belleview sprayfield in 1997.

Species	Depth	Al	B	Cu	Zn
		lbs/ac			
Bahia	0-6	1052	0.94	0.85	3.10
	6-12	1148	0.38	0.63	0.86
	12-24	2258	0.67	0.62	0.77
	24-36	2304	0.69	0.54	0.59
Gama	0-6	1050	0.75	0.76	2.76
	6-12	1179	0.32	0.55	1.01
	12-24	2351	0.89	0.53	0.33
	24-36	2493	0.55	0.39	0.37
Alamo	0-6	1069	1.01	0.65	2.52
	6-12	1262	0.38	0.54	0.69
	12-24	2300	0.62	0.53	0.41
	24-36	2114	0.38	0.42	0.53
Sharp	0-6	950	0.53	0.95	2.86
	6-12	1027	0.27	1.14	1.00
	12-24	2034	0.46	0.69	0.74
	24-36	2124	0.44	0.50	0.35
Bermuda	0-6	875	0.54	0.57	2.51
	6-12	1199	0.45	0.42	1.09
	12-24	2325	0.60	0.52	0.49
	24-36	2379	1.21	0.32	0.43
Peanut	0-6	1131	0.52	0.92	2.96
	6-12	1256	0.38	1.00	1.40
	12-24	2115	0.58	0.58	1.03
	24-36	2067	0.48	0.40	0.40
Limpograss	0-6	1136	2.28	0.79	3.32
	6-12	1308	0.73	0.56	1.13
	12-24	2175	0.79	0.65	0.53
	24-36	2624	0.87	0.29	0.35
Defuniak	0-6	1031	2.25	0.83	2.67
	6-12	1106	0.49	0.37	1.08
	12-24	2269	0.66	0.57	0.52
	24-36	2213	0.62	0.34	0.54
Mott	0-6	956	0.63	0.78	2.92
	6-12	1120	0.39	0.59	0.90
	12-24	2298	0.71	0.45	0.37
	24-36	2162	0.49	0.42	0.38

Table 19. Soil P, K and Ca in soil samples taken in 1997 and 1998, and expressed as a percent of 1996 levels.

Species	Depth	P as % of '96		K as % of '96		Ca as % of '96	
		1997	**1998**	**1997**	**1998**	**1997**	**1998**
Bahia	0-6	227	122	248	205	422	390
	6-12	169	90	167	158	236	188
	12-24	101	67	174	173	255	158
	24-36	87	25	105	108	81	17
Gama	0-6	199	139	259	291	407	487
	6-12	159	31	100	127	221	117
	12-24	94	30	110	74	137	48
	24-36	85	29	86	98	55	20
Alamo	0-6	217	95	190	127	377	355
	6-12	126	70	126	146	133	202
	12-24	122	30	108	189	108	219
	24-36	88	31	52	106	40	17
Sharp	0-6	217	134	189	211	360	442
	6-12	127	40	143	145	144	138
	12-24	95	27	144	232	150	130
	24-36	83	22	105	95	47	23
Bermuda	0-6	218	169	269	161	361	511
	6-12	196	141	237	204	242	386
	12-24	103	72	138	177	101	267
	24-36	101	44	104	143	52	34
Peanut	0-6	272	104	180	286	429	178
	6-12	212	138	139	118	247	355
	12-24	124	57	114	61	224	84
	24-36	93	33	75	95	55	16
Limpograss	0-6	237	151	286	359	484	501
	6-12	162	61	116	97	177	206
	12-24	87	44	132	185	143	109
	24-36	91	33	98	163	68	30
Defuniak	0-6	234	156	210	180	400	466
	6-12	122	66	120	198	144	138
	12-24	92	42	113	221	131	103
	24-36	86	26	84	108	54	18
Mott	0-6	214	135	256	196	446	478
	6-12	101	57	151	180	187	223
	12-24	98	25	37	82	139	58
	24-36	73	33	40	197	44	17

Table 20. Soil Mg, Na and Fe in soil samples taken in 1997 and 1998, and expressed as a percent of 1996 levels.

Species	Depth	Mg as a % of '96		Na as a % of '96		Fe as a % of '96	
		1997	1998	1997	1998	1997	1998
Bahia	0-6	442	380	328	109	108	63
	6-12	200	201	229	161	91	57
	12-24	207	197	179	151	97	79
	24-36	112	70	140	99	140	91
Gama	0-6	517	523	451	336	108	120
	6-12	234	160	342	224	95	62
	12-24	148	111	191	148	112	79
	24-36	85	71	164	132	143	104
Alamo	0-6	459	337	293	135	104	70
	6-12	136	197	199	141	94	58
	12-24	113	230	133	114	103	63
	24-36	73	58	109	99	124	81
Sharp	0-6	396	412	267	124	93	64
	6-12	135	160	161	140	77	47
	12-24	145	157	133	116	96	57
	24-36	74	78	120	115	122	79
Bermuda	0-6	369	459	224	85	100	66
	6-12	230	392	200	137	101	93
	12-24	102	254	124	99	118	98
	24-36	73	93	105	95	145	233
Peanut	0-6	455	223	326	109	125	68
	6-12	239	316	253	94	104	73
	12-24	191	121	148	103	109	77
	24-36	79	51	124	76	126	89
Limpograss	0-6	531	530	311	176	121	86
	6-12	154	249	208	149	109	71
	12-24	126	152	140	128	96	93
	24-36	100	77	141	101	149	112
Defuniak	0-6	411	424	289	102	103	67
	6-12	141	157	194	147	84	52
	12-24	118	149	146	131	105	74
	24-36	77	78	124	128	130	87
Mott	0-6	518	539	380	101	104	76
	6-12	180	274	303	159	77	65
	12-24	122	140	207	117	105	80
	24-36	73	67	156	104	131	115

Table 21. Soil Al, B and Cu in soil samples taken in 1997 and 1998, and expressed as a percent of 1996 levels.

Species	Depth	Al as a % of '96		B as a% of '96		Cu as a% of '96	
		1997	1998	1997	1998	1997	1998
Bahia	0-6	91	47	70	147	51	32
	6-12	102	62	45	50	46	24
	12-24	105	82	41	40	30	27
	24-36	117	78	50	39	60	31
Gama	0-6	91	56	56	26	46	28
	6-12	105	76	39	23	40	14
	12-24	110	83	55	23	26	22
	24-36	126	94	40	21	43	23
Alamo	0-6	93	52	76	65	39	31
	6-12	112	67	45	69	39	20
	12-24	107	66	38	40	26	30
	24-36	107	76	28	43	46	49
Sharp	0-6	82	46	40	27	57	25
	6-12	91	51	32	26	83	14
	12-24	95	54	28	22	33	23
	24-36	107	66	32	36	56	30
Bermuda	0-6	76	56	40	17	34	21
	6-12	107	97	54	116	31	28
	12-24	109	94	37	33	25	18
	24-36	120	96	87	32	36	76
Peanut	0-6	98	59	39	15	55	19
	6-12	112	62	46	25	73	30
	12-24	99	78	36	17	28	25
	24-36	105	75	34	17	45	29
Limpograss	0-6	99	73	171	44	47	32
	6-12	116	80	87	33	41	17
	12-24	102	98	49	17	31	22
	24-36	133	100	63	17	33	31
Defuniak	0-6	89	55	168	22	50	26
	6-12	98	59	59	18	27	41
	12-24	106	76	41	19	28	26
	24-36	112	78	45	17	38	24
Mott	0-6	83	61	47	19	47	25
	6-12	100	81	47	7	43	21
	12-24	107	84	44	11	22	30
	24-36	109	103	36	10	47	45

Table 22. Soil Zn and Mn in soil samples taken in 1997 and 1998, and expressed as a percent of 1996 levels.

Species	Depth	Zn as a % of '96		Mn as a % of '96	
		1997	1998	1997	1998
Bahia	0-6	328	111	216	43
	6-12	149	66	129	31
	12-24	133	66	110	47
	24-36	46	23	89	26
Gama	0-6	292	121	192	51
	6-12	176	50	108	27
	12-24	57	48	89	34
	24-36	28	19	108	34
Alamo	0-6	266	134	168	54
	6-12	120	74	112	29
	12-24	71	57	109	29
	24-36	41	24	89	37
Sharp	0-6	303	182	145	58
	6-12	174	56	87	22
	12-24	127	47	84	27
	24-36	27	20	79	27
Bermuda	0-6	265	136	143	38
	6-12	190	105	112	48
	12-24	84	95	87	41
	24-36	33	29	90	39
Peanut	0-6	314	75	212	41
	6-12	244	148	142	69
	12-24	177	49	112	47
	24-36	31	16	92	30
Limpograss	0-6	351	168	267	99
	6-12	197	74	172	56
	12-24	92	45	138	57
	24-36	27	20	138	43
Defuniak	0-6	283	181	156	64
	6-12	188	68	89	26
	12-24	90	65	146	47
	24-36	41	25	119	38
Mott	0-6	309	166	205	74
	6-12	158	97	116	40
	12-24	63	46	121	38
	24-36	30	19	100	42

Table 23. Soil pH, and lbs./ac. nitrogen, phosphorous and potassium per sampled depth. Numbers are averages of 4 reps per depth, taken at the Belleview sprayfield in 1998.

Species	Depth	Code	pH	Nh4	No3	P	K
				lbs/ac			
Bahia	0-6	1	5.5	0.48	19	120	59
	6-12	1	4.8	0.72	17	69	38
	12-24	1	4.6	1.01	37	90	64
	24-36	1	4.3	1.20	37	39	50
Gama	0-6	2	5.6	0.68	18	136	84
	6-12	2	4.5	0.40	19	24	30
	12-24	2	4.3	1.53	39	40	28
	24-36	2	4.2	0.70	42	45	45
Alamo	0-6	3	5.3	0.68	21	93	37
	6-12	3	4.8	0.88	18	54	35
	12-24	3	4.8	1.40	38	41	70
	24-36	3	4.2	1.97	43	47	49
Sharp	0-6	4	5.5	0.59	20	131	61
	6-12	4	4.6	0.62	21	31	35
	12-24	4	4.6	0.94	39	36	86
	24-36	4	4.4	1.74	40	34	44
Bermuda	0-6	6	5.6	0.86	21	165	46
	6-12	6	5.0	0.78	20	109	49
	12-24	6	4.7	1.37	38	98	66
	24-36	6	4.6	1.59	39	69	66
Peanut	0-6	7	5.1	0.72	20	101	83
	6-12	7	5.0	0.78	20	107	28
	12-24	7	4.4	1.67	32	77	23
	24-36	7	4.2	1.85	38	51	44
Limpograss	0-6	8	5.5	0.50	18	147	104
	6-12	8	4.7	0.98	19	47	23
	12-24	8	4.4	1.34	37	60	69
	24-36	8	4.4	1.72	38	50	75
Defuniak	0-6	9	5.1	0.47	18	153	52
	6-12	9	4.9	0.71	22	51	47
	12-24	9	4.5	1.58	39	56	82
	24-36	9	4.3	0.82	43	40	50
Mott	0-6	10	5.6	0.91	19	132	57
	6-12	10	4.8	0.49	19	44	43
	12-24	10	4.4	1.33	37	34	31
	24-36	10	4.2	1.16	39	52	91

Table 24. Soil lbs./ac. Ca, Mg, Na and Fe per sampled depth. Numbers are averages of 4 reps per depth, taken at the Belleview sprayfield in 1998.

Species	Depth	Ca	Mg	Na	Fe
		lbs/ac			
Bahia	0-6	705	79	22	69
	6-12	228	32	30	66
	12-24	171	44	54	189
	24-36	40	23	38	181
Gama	0-6	880	108	69	131
	6-12	142	25	42	72
	12-24	52	25	53	188
	24-36	45	23	50	205
Alamo	0-6	642	70	28	77
	6-12	245	31	26	67
	12-24	236	51	41	150
	24-36	40	19	38	161
Sharp	0-6	799	85	25	70
	6-12	167	25	26	55
	12-24	140	35	41	134
	24-36	54	25	44	157
Bermuda	0-6	924	95	17	72
	6-12	468	62	26	108
	12-24	289	56	36	232
	24-36	79	30	36	461
Peanut	0-6	321	46	22	74
	6-12	430	50	18	84
	12-24	91	27	37	183
	24-36	37	16	29	175
Limpograss	0-6	906	109	36	95
	6-12	249	39	28	82
	12-24	118	34	46	222
	24-36	70	25	39	222
Defuniak	0-6	843	88	21	74
	6-12	167	25	28	61
	12-24	111	33	47	176
	24-36	41	25	49	171
Mott	0-6	864	111	21	83
	6-12	270	43	30	76
	12-24	62	31	42	189
	24-36	38	21	39	228

Table 25. Soil lbs./ac. Al, B, Cu, Zn and Mn per sampled depth. Numbers are averages of 4 reps per depth, taken at the Belleview sprayfield in 1998.

Species	Depth	Al	B	Cu	Zn	Mn
		lbs/ac				
Bahia	0-6	547	1.96	0.53	1.05	3.37
	6-12	699	0.42	0.32	0.38	2.02
	12-24	1766	0.64	0.56	0.38	4.57
	24-36	1537	0.54	0.28	0.30	3.23
Gama	0-6	645	0.35	0.46	1.14	4.04
	6-12	851	0.19	0.20	0.29	1.73
	12-24	1774	0.37	0.45	0.28	3.28
	24-36	1863	0.29	0.20	0.24	4.14
Alamo	0-6	598	0.86	0.51	1.27	4.30
	6-12	756	0.58	0.28	0.42	1.88
	12-24	1421	0.65	0.61	0.33	2.83
	24-36	1501	0.60	0.44	0.32	4.59
Sharp	0-6	530	0.36	0.43	1.72	4.62
	6-12	576	0.21	0.19	0.32	1.45
	12-24	1153	0.36	0.48	0.27	2.60
	24-36	1297	0.50	0.27	0.26	3.29
Bermuda	0-6	645	0.22	0.34	1.28	3.04
	6-12	1085	0.96	0.38	0.60	3.15
	12-24	2013	0.53	0.36	0.55	3.97
	24-36	1889	0.44	0.68	0.38	4.76
Peanut	0-6	683	0.20	0.32	0.71	3.23
	6-12	701	0.21	0.42	0.85	4.51
	12-24	1669	0.27	0.51	0.29	4.60
	24-36	1479	0.23	0.26	0.21	3.64
Limpograss	0-6	841	0.59	0.54	1.59	7.88
	6-12	898	0.28	0.23	0.42	3.61
	12-24	2104	0.27	0.45	0.26	5.57
	24-36	1974	0.23	0.28	0.25	5.28
Defuniak	0-6	636	0.30	0.44	1.71	5.04
	6-12	660	0.15	0.56	0.39	1.68
	12-24	1627	0.31	0.53	0.38	4.58
	24-36	1543	0.23	0.22	0.32	4.63
Mott	0-6	698	0.26	0.41	1.57	5.83
	6-12	915	0.06	0.28	0.56	2.59
	12-24	1801	0.18	0.63	0.27	3.69
	24-36	2036	0.13	0.41	0.25	5.12