TECHNICAL NOTES

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Arizona Irrigated Pasture Trials 2001 to 2005

Abstract

Forage grasses were evaluated at three locations in Arizona for use in irrigated pastures. The locations included the Tucson Plant Materials Center (PMC), Tucson, Prescott, and Nogales, Arizona. The PMC location conducted three years of trials for the following species: giant, common, and 'Cheyenne' bermuda grass (Cynodon dactylon (L.) Pers.), 'Vaughn' sideoats grama (Bouteloua curtipendula (Michx.) Torr.), 'Loetta' Arizona cottontop (Digitaria californica (Benth.) Henr.), big sacaton (Sporobolus wrightii Munro ex Scribn.),'Tango' prairie brome grass (Bromus catharticus Vahl.) and 'Jesup' tall fescue (Lolium arundinaceum (Schreb.) S.J. Darbyshire) with MaxQ™ treatment (non-toxic endophyte). The Nogales planting included five species: common, giant, and 'Cheyenne' bermuda grass, 'Vaughn' sideoats grama, big sacaton, and 'Palar' Wilman lovegrass (Eragrostis superba Peyr.). The Prescott plantings included 'Jesup' tall fescue, 'Alta' tall fescue (Lolium arundinaceum (Schreb.) S.J. Darbyshire), and 'Cheyenne' bermuda grass. At the PMC the most productive species were the three bermuda grasses followed closely by sideoats grama. The Nogales planting found 'Palar' Wilman lovegrass had the lowest grazing preference by cattle and was competitive with existing bermuda grass and broadleaf weeds. The Nogales planting found 'Vaughn' sideoats grama to be productive, able to withstand grazing pressure, and compete with existing weeds. The Prescott plantings have shown that 'Cheyenne' bermuda grass will survive at elevations up to 5,000 feet and that 'Jesup' tall fescue was more productive than 'Alta' tall fescue. This information can be applied to conservation practices such as Pasture and Hay Planting (512) and Prescribed Grazing (528A).

Introduction

Drought is a naturally recurring phenomenon in the Southwest. Declining forage on our rangelands, due to drought, has caused livestock growers to search for other forage sources such as irrigated pastures to maintain their livestock herds. Due to renewed interest in irrigated pastures the Tucson Plant Materials Center (PMC) evaluated new varieties of commonly used forage species as well as native grasses with potential as forage species. Trials at the PMC started in 2001 and were terminated in the fall of 2004. Prescott trials were started in 2002 and ended in 2005. Grazing preference trials in Nogales began in 2002 and ended in 2005. Table 1 lists planting locations, species sown by location, and planting dates for this study.

Materials and Methods

Tucson PMC

'Vaughn' sideoats grama, 'Loetta: Arizona cottontop and three bermuda grass types (common, giant, and Cheyenne') were sown in June 2001. The bermuda grass types are seeded types. Cool season grasses ('Jesup' tall fescue, and 'Tango' prairie brome grass (formerly *Bromus wildenowii* Kunth.) were sown in October 2001. Big

sacaton was sown May 2002. All species were broadcast seeded. See Table 2 for seeding rates and planting locations at the PMC.

Field preparation included rotovating, harrowing, and pre-irrigation. Seed was broadcast on a prepared, moist seedbed and then harrowed to incorporate the seed into the soil surface. Irrigations were frequent (2 times per week) during the 2 week establishment period. Following establishment, irrigations were once or twice a month during the growing season and typically applied after forage was removed from the field. Table 11 lists total water applied at the PMC. Elevation at the PMC is 2,285 feet and the soil is a Comoro fine sandy loam.

A single application of a broadleaf herbicide, Grazon™ P+D, was applied during the post three-leaf stage of growth to help control annual summer weeds. Only one application of herbicide was necessary for all species planted in 2001. Big sacaton, planted in 2002, received two applications of Savage™, a broadleaf herbicide. No additional pesticides were applied. Fertilizer applications were as follows:

200 lbs/ac. of ammonium phosphate (16-20-0), 24 September 2002
200 lbs/ac of urea (46-0-0), 26 March 2003
150 lbs/ac of urea, 17 June 2003
100 lbs/ac of urea, 11 March 2004.

Forage sampling was conducted by clipping the grasses within a 4.6 ft^2 rectangular frame using a hand-held grass clipper. Grasses were clipped to a height of 3 inches. Three samples, equally spaced within the border, were clipped each month, typically from May through October. Forage measurements, in grams, included fresh weight and dry weight. Dry weight was measured approximately 30 days after harvest. Weights were converted to pounds of forage per acre by multiplying the average weight of the three samples, for each species, by 20. Forage height, prior to sampling, was not measured.

Water use efficiency (WUE) is included to address the issue that native grasses should be more water efficient than introduced grasses. This information should only be used for comparisons between the different species. Plant growth habit (bunch vs. sod-forming) and irrigation system efficiency will dictate the amount of irrigation water applied. Water use efficiency was calculated by dividing total production by total amount of water applied. Therefore, the higher the number the more forage is produced per unit of water.

Forage analysis for 2001 was conducted for the three bermuda grass varieties using the August samples. The 2002 forage analysis was conducted using the September samples and the 2003 and 2004 forage analysis was conducted using the June samples. Analysis reports measured crude protein (CP), total digestible nutrients (TDN), acid detergent fiber (ADF), and neutral detergent fiber (NDF). The Penn State equation (TDN=102.327 – 1.113 X ADF) was used to calculate TDN. Forage samples were air dried for at least 60 days prior to analysis. As a general reference, baled alfalfa has a CP value between 13 and 16 and TDN values between 50 and 56 (Smith, S.E. May, 2005. University of Arizona. 520-621-5325)

Prescott

The fescue planting was a comparison between ‘Jesup’ (non-toxic endophyte) and ‘Alta’ (endophyte free) tall fescue. Planting was conducted on 21 June 2002. One acre was planted for each variety using twenty-five pounds of seed per acre seeding rate. The elevation of this site is 4,780 feet and the soil is a Lynx, moderately deep, with textures ranging from loam to clay loam. Irrigation was applied using a sprinkler system. Number of irrigations was not recorded.

The bermuda grass planting was conducted to help determine the elevation range of bermuda grass varieties that are cold tolerant such as the ‘Cheyenne’ variety. Approximately 7.5 bulk pounds of seed was broadcast seeded over ¼ acre. Irrigation was applied by fixed sprinkler system but number of irrigations was not recorded. Elevation at this site is 4,848 feet and the soils are moderately deep, gravelly, and coarse textured.

Nogales

This planting consisted of common, giant, and ‘Cheyenne’ bermuda grass, big sacaton, ‘Palar’ Wilman lovegrass, and ‘Vaughn’ sideoats grama. Planting was conducted on 10 July 2002. Seed was sown using a hand held broadcast seeder as well as a push type broadcast seeder used to sow ‘Vaughn’ and giant. Plots were then harrowed

to incorporate the seed into the soil surface. Irrigations were applied every 7 to 10 days using a flooded border system. No fertilizer or herbicides were applied during establishment. Elevation at this site is 3,750 feet and the soils vary from Comoro sandy loam to Grabe loam.

Results and Discussion

2001

Tucson PMC

Only one sample, from the three bermuda grass plots, was conducted the first year. 'Loetta' and 'Vaughn' were not sampled because of their slow establishment rate and an abundance of summer weeds. Of the bermuda grass varieties, giant was the most vigorous with regards to speed of emergence and stand establishment. 'Cheyenne' was slower to germinate and establish than both the giant and common varieties. However, by October 2001 'Cheyenne' had achieved a uniform and productive stand. The cool season grasses ('Jesup' and 'Tango') were seeded on 30 October but were not evaluated for forage production in 2001. 'Tango' had strong seedling vigor and formed a good stand. It was evident, quite quickly, that 'Tango' was preferred forage for our local rabbit population. Rabbits grazed out the lower 1/3 of this plot by the winter of 2001. 'Jesup' was slow to establish into a uniform stand and growth was slow throughout the winter months. The 14 August production is listed in Table 3.

Forage quality was determined for the three bermuda grasses using the 14 August sample. 'Cheyenne' had the highest CP (17.5%) followed by giant (14.4%) and common (13.8%). Common had the highest TDN at 67.8 percent. 'Cheyenne' and giant had TDN values slightly lower than common. Samples were analyzed by the Jamie L. Whitten PMC. No supplemental fertilizer was applied in 2001. Forage quality (CP and TDN) for 2001 is listed in Tables 8 and 9.

2002

Tucson PMC

Big sacaton was planted in May. Big sacaton has slow seedling growth, stand establishment, and competition from weeds can severely impact the stand. Savage™, a broadleaf herbicide, was applied in June and July to control summer broadleaf weeds. Mowing was also used to reduce weed competition in the big sacaton planting. 'Vaughn' had the highest total production (15,653) followed by giant (14,814) and 'Cheyenne' (11,844) bermuda grass. 'Vaughn' had greater production in May and June compared to giant bermuda grass which had its greatest production in July and August.

Forage analysis for 'Tango' and 'Jesup' was conducted on the 14 August sample. 'Tango' and 'Jesup' had CP levels of 15 and 14.9 percent and TDN at 61 and 62.8 percent, respectively. Forage analysis on the warm season grasses was conducted on the September sample. Common bermuda grass had the highest CP (16.5) and TDN (59.3) of the warm season grasses. Two hundred pounds of ammonium phosphate (16-20-0) fertilizer was applied to all species on 24 September to aid with residue breakdown. It was evident that productivity and plant vigor were reduced for all species due to lack of fertilization during the growing season.

'Vaughn' had the highest WUE at 361.5 pounds of forage produced per inch of water applied.

See Table 4 for forage production by sample date. See Tables 8 through 11 for forage quality, WUE, and total water applied by year.

Prescott

Planting was installed on 21 June. Irrigations were conducted at least once a week for establishment but number and amount of water applied were not recorded. Pasture was not grazed to allow for plant establishment.

Nogales

In September 2002 the planting the planting had an abundance of competition from annual weeds. All species had germinated but due to weed competition and cover it was difficult to assess the stand. The cooperator planned to mow the plots to a height of 3 inches to reduce competition.

2003

Tucson PMC

An application of 200 lbs of urea was applied to all species on 26 March. Monthly sampling began on 26 April for the 'Jesup' and 6 May for the warm season grasses. Sampling ended on 22 October. In May common bermuda grass had its lowest monthly production of the year due to large, yellow, unproductive spots in the border. 'Jesup' had the highest May production (2,625). The 6 June sample found common (3,793) had regained its productivity but giant (5,360) was the top producer followed by 'Cheyenne' (4,826). In June an additional application of 150 lbs of urea was applied. The July sample shows all species declined in forage production due to high summer temperatures, low humidity, and only one irrigation application. The highest monthly production for all species occurred in August. Giant had the highest production (5,193) followed by common (4,760) and 'Vaughn' (4,726). We believe this dramatic increase in production was due to the application of urea (46-0-0) in June along with rainfall received the last of July and beginning of August. Total annual production was highest for giant (19,066) followed by 'Cheyenne' (17,732) and common (17,032). 'Vaughn' had the highest production of the native grasses (16,032).

The 6 June samples were analyzed for forage quality. Giant had the highest CP at 22.13 percent. 'Jesup' had the highest TDN at 67.06 percent. Of the native grasses, 'Vaughn' had the highest CP at 19.36 percent and tied with 'Loetta" for the highest TDN at 58.53 percent.

Water use efficiency was highest for big sacaton at 335.5 pounds of forage produced per inch of water followed by 'Vaughn' at 282.8.

See Table 5 for 2003 forage production by sample date. See Tables 8 through 11 for forage quality, WUE, and total water applied by year.

Prescott

Irrigations in 2003 supplied 8 to 10 inches of water with another 8 inches of water from summer rainfall. No fertilization was applied. One application of a broadleaf herbicide, to control field bindweed (*Convolvulus arvensis* L.), was applied in 2003. Site was inspected on 5 November. Both tall fescue varieties have productive dense stands. 'Jesup' appears more robust and has a deeper green color. Density and production measurements were conducted during the 5 November evaluation. Stand density for both varieties was 12 plants/ft^2. Production measurements, using a 0.96 ft^2 frame with four replications, found 'Jesup' producing 3,150 pounds per acre and 'Alta' producing 2,400 pounds per acre.

Nogales

This trial was grazed during 2003 but evaluations were not conducted.

2004/2005

Tucson PMC

Sampling started on 12 April for 'Jesup' and 24 April for the warm season grasses. Additional forage samples were conducted on 8 June, 9 July, 12 August, and a final sample on 1 October. Urea was applied at a rate of 100 pounds (46 lbs. of N) per acre on 11 March. The April sample of 'Jesup' (3,460) appeared to show response from the 11 March fertilization while the warm season grasses appeared to delay their response until the June sample. In June the four introduced grasses received two irrigations versus one for the native grasses. The June samples show common bermuda grass (5,900) appeared to benefit the most from the extra irrigation when compared to its production in June 2003 (3,793). 'Cheyenne' and giant as well as 'Jesup' showed a slight decrease in production in the June 2004 versus June 2003 even with an additional irrigation. This reduction is probably due to sampling error. The native grasses, which received one June irrigation, big sacaton (4,060), and 'Vaughn' (5,460), had 500 and 2000 pound increases, respectively, when compared to June 2003. The reason for this increase is not clear but it could be an effect from residual nitrogen. The July sample, as in 2003, found a marked decrease in production for all species. Total annual production was highest for common bermuda grass (16,732) followed by giant (16,214) and 'Cheyenne' (15,407). 'Vaughn' (15,294) had the highest total production for the native grasses.

Forage analysis was conducted on the 8 June samples. 'Cheyenne' had the highest CP (16.69) followed by 'Jesup' (16.59) and common (15.91). Giant had the highest TDN (63.22) followed by 'Cheyenne' (61.31) and 'Jesup'

(60.40). 'Loetta' had the highest CP (11.8) and TDN (59.83) of the native grasses. 'Vaughn' had its lowest CP (8.78) for the entire study even though its June production (5,460) was its highest. It is thought that this low CP was due to drought stress, at time of sampling, because it had been 32 days since it was irrigated.

Water use efficiency was higher for the native grasses than the introduced species. 'Vaughn' had the highest WUE at 371.2 pounds of forage per inch of applied water followed by big sacaton (279.8) and giant (221.2).

See Table 6 for forage production by sample date. See Tables 8 through 11 for forage quality, WUE, and total water applied by year.

Prescott

Trial was grazed during the summer of 2004 and allowed to grow to a height of 24 inches before it was mowed in the fall. In the spring of 2005 the pasture received a light application (25 lbs.) of ammonium phosphate (16-20-0). The planting was evaluated in April 2005 for stand and production. 'Jesup' had a stand density of 17.8 plants/ft^2 up from the 2004 measurement of 12 plants/ft^2. 'Alta' had a stand density of 15.6 plants/ft^2 up from the 2004 measurement of 12 plants/ft^2. Fresh weight production measurements were 1,700 lbs/ac for 'Jesup' and 1,100 lbs/ac for 'Alta'.

Nogales

Observations in 2004 indicate that cattle had the least preference for Wilman lovegrass. Irrigations were not recorded but were generally applied on a 12 to 14 day cycle during the summer months. Percent stand was evaluated in 13 May 2005 to determine number of plants per square foot. 'Vaughn' had the highest plant density at 21 plts/ft^2 followed by 'Cheyenne' (20.7), common (16.7), giant (15.6), Wilman lovegrass (14.6), and big sacaton (6.7). The pasture had been grazed up to 10 May and will be rested through July. Fifty pounds of nitrogen was applied on 28 May. Forage samples, fresh weight, were taken on 16 June using a 0.96 ft2 frame and averaging the production from 3 random samples for each species. Fresh weight production was 4,833 lbs. for 'Cheyenne', 4,733 lbs for 'Vaughn', 6,400 lbs for giant, 4,500 lbs for big sacaton, 4,300 lbs for common, and 8,233 lbs for Wilman. The high production for Wilman lovegrass was due to it being fully headed out and in flower. Average plant height was 7 to 8 inches except big sacaton was 13 inches and Wilman lovegrass was 17 inches. Stand observations found 'Cheyenne' and 'Vaughn' had good stands and competed well with pre-existing bermuda grass and broadleaf weeds. Big sacaton had the lowest stand density but it was still productive due to its tall growth form. Wilman lovegrass exhibited a strong ability to compete with pre-existing bermuda grass and herbaceous broadleaf weeds.

Conclusions

'Vaughn' sideoats grama developed and maintained excellent and productive stands in all trials. Annual production for 'Vaughn' was consistent over the length of this study and 'Vaughn' would be a good choice as an irrigated pasture grass. The three bermuda grasses had the highest overall performance with regards to quality and production. Giant was the top producer the first three years of the trial and was a close second to common in year four. Big sacaton has maintained a productive stand but is not as productive as any of the three bermuda grasses or 'Vaughn' sideoats grama. The native grasses used in this trial have slow stand establishment rates and require proper weed control practices to ensure good stand establishment. Also, native grasses should not be grazed for at least the first growing season to allow for proper plant establishment and stand development. 'Jesup' tall fescue has been a disappointment with regard to productivity at Tucson. Spring and late fall production is fair and summer production is poor. However, 'Jesup' performed well at the high elevation planting near Prescott and should be considered for use in irrigated pastures at elevations above 3,500 feet. 'Alta' tall fescue had lower productivity and plant density compared to 'Jesup'. 'Cheyenne' bermuda grass persisted at elevations above 4,500 feet where it appeared to maintain a healthy and productive stand. However, we do not have enough performance information to make recommendations regarding its use at elevations above 3,500 feet. 'Loetta' Arizona cottontop, due to declining stand and low productivity, is a poor choice for irrigated pastures in Arizona. 'Tango' prairie bromegrass, a palatable cool season grass, has some special considerations. 'Tango' requires protection from uncontrolled grazing by local fauna, good fertility, plenty of moisture, reduced grazing during the summer months, and should be allowed to go to seed every 2 to 3 years to maintain the stand.

Forage production was increased for all species using split applications of fertilizer as shown in Table 3. The grazing preference study showed little difference between the three bermuda grass varieties and 'Vaughn' sideoats grama with regards to preference, stand establishment, and stand persistence. 'Palar' Wilman lovegrass had the

lowest grazing preference of the six species evaluated but was very productive and competed well with pre-existing bermuda grass and herbaceous weeds. See Table 7 for total annual production by species by year.

Forage analysis has shown the bermuda grass varieties generally had higher CP and TDN as compared to the native grasses. However in 2003 the three native grasses had comparable CP content to the bermuda grass varieties. The higher CP content for the native grasses in 2003 may have been due to the March application of urea. This study reinforces the practice of applying split applications of fertilizer to optimize forage production and quality.

Water use efficiency values were highest for the native grasses, especially 'Vaughn' sideoats grama. This trial did not evaluate production with reduced applications of water. It may be incorrect to say native grasses produce more than the introduced grass with reduced irrigations. But, native grasses did produce more forage per unit of water applied. If a producer wants the highest producing species, regardless of the amount of water applied, then one of the bermuda grass varieties appears to be the best choice. If water is a limiting input than 'Vaughn' sideoats grama would be a preferred choice.

This information can be applied to conservation practices such as Pasture and Hay Planting (512) and Prescribed Grazing (528A).

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Table 1
Planting Locations, Species Planted, Planting Dates

LOCATION	SPECIES	PLANTING DATE
Tucson Plant Materials Center	'Jesup' tall fescue	October 2001
	'Cheyenne' bermuda grass	June 2001
	common bermuda grass	June 2001
	giant bermuda grass	June 2001
	'Loetta' Arizona cottontop	June 2001
	big sacaton	May 2002
	'Vaughn' sideoats grama	June 2001
	'Tango' prairie brome grass	October 2001
Prescott	'Jesup' tall fescue	June 2002
	'Alta' tall fescue	June 2002
	'Cheyenne' bermuda grass	June 2002
Nogales	'Cheyenne' bermuda grass	July 2002
	'Vaughn' sideoats grama	July 2002
	giant bermuda grass	July 2002
	big sacaton	July 2002
	common bermuda grass	July 2002
	'Palar' Wilman lovegrass	July 2002

Table 2
IRRIGATED PASTURE SPECIES TRIAL SEEDING INFORMATION
Field 1, Borders 3-8
Tucson Plant Materials Center

SPECIES	Broadcast PLS RATE (lbs./acre)	AREA (acres)	ACTUAL PLS AMOUNT NEEDED (lbs.)	ACCESSION INFORMATION	ACTUAL BULK AMOUNT SEEDED (lbs.)
'Jesup' tall fescue	13.0	0.2	2.6	L99-I-29 PLS: 89.5%	5.0 lbs seeded
'Cheyenne' bermudagrass	1.0	0.2	0.2	SCO-01-7018 PLS: 50%	3.75 lbs.
Common bermudagrass	1.0	0.2	0.2	SCO-01-7016 PLS: 80%	3.4 lbs.
Giant bermudagrass	1.0	0.2	0.2	SCO-01-7017 PLS: 80%	3.4 lbs.
'Loetta' Arizona cottontop	8.0	0.2	1.6	SCO-99-6985 PLS: 66%	2.4 lbs. (1.6 ÷ .66)
'Vaughn' sideoats grama	15.0	0.2	3.0	PLS = 74%	5 lbs.
'Tango' Prairie bromegrass		0.15			11.0 lbs seeded

Table 3
2001 (August 14 Sample)
Forage Production (dry weight-lbs/ac)
Tucson Plant Materials Center

Sample Date	'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	'Vaughn' sideoats grama	'Tango' prairie brome grass
August 14	N/A	1,570	1,350	2,567	N/A	N/A	N/A
TOTAL PRODUCTION	**N/A**	**1,570**	**1,350**	**2,567**	**N/A**	**N/A**	**N/A**

Table 4
2002
Forage Production (dry weight-lbs/ac) by sample date
Tucson Plant Materials Center

Sample Dates	'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	'Vaughn' sideoats grama	'Tango' prairie brome grass
May 5	752	2,402	2,420	4,052	2,183	4,712	not sampled
June 24	1,077	3,442	2,342	3,662	1,902	4,542	1,517
August 1[1]	866	3,600	2,433	4,200	2,066	3,666	433
September 6[2]	not sampled	2,400	1,333	2,900	2,166	2,733	not sampled
TOTAL PRODUCTION	**2,695**	**11,844**	**8,528**	**14,814**	**8,317**	**15,653**	**1,950**

1-Forage quality conducted on August 1st sample for tall fescue & prairie brome grass,
2-Forage quality conducted on September 6th for warm-season grasses and applied 200 lbs of 16-20-0 on September 24.

Table 5
2003
Forage Production (dry weight-lbs/ac) by Sample Date
Tucson Plant Materials Center

Sample Dates	'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	Big sacaton	'Vaughn' sideoats grama
May 6[1]	2,625	2,000	500	1,567	600	2,200	2,166
June 6[2]	1,760	4,826	3,793	5,360	2,360	3,492	3,526
July 7	960	1,426	2,326	2,026	1,594	2,394	1,460
August 7[3]	1,293	4,527	4,760	5,193	3,427	4,060	4,726
September 7	not sampled	2,460	2,960	2,493	893	1,760	1,527
October 22	1,960	2,493	2,693	2,427	1,527	1,460	2,627
TOTAL PRODUCTION	**8,598**	**17,732**	**17,032**	**19,066**	**10,401**	**15,366**	**16,032**

1-March 26 applied 200 lbs of urea
2-Forage analysis conducted on this sample
3-June 17 applied 150 lbs of urea

Table 6
2004
Forage Production (dry weight-lbs/ac) by Sampling Date
Tucson Plant Materials Center

Sample Dates	'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	Big sacaton	'Vaughn' sideoats grama
April 24[1]	3,460	3,360	3,526	2,800	920	2,560	3,120
June 8[2]	1,600	4,560	5,900	5,300	1,820	4,060	5,460
July 9	1,020	1,800	1,820	2,560	1,320	2,100	2,160
August 12	694	3,127	2,360	3,294	1,726	1,494	2,494
September 30	1,494	2,560	3,126	2,260	1,826	1,960	2,060
TOTAL PRODUCTION	**8,268**	**15,407**	**16,732**	**16,214**	**7,612**	**12,174**	**15,294**

1-'Jesup' tall fescue sampled on April 12; March 11 applied 100 lbs of urea
2-Forage analysis conducted on this sample

Table 7
Total Annual Production at Tucson Plant Materials Center

Total Annual Production	'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	Big sacaton	'Vaughn' sideoats grama	'Tango' prairie brome grass
2001	N/A	1,570	1,350	2,567	N/A	N/A	N/A	N/A
2002	2,695	11,844	8,528	14,814	8,317	N/A	15,653	1,950
2003	8,598	17,732	17,032	19,066	10,401	15,366	16,032	Out
2004	8,268	15,407	16,732	16,214	7,612	12,174	15,294	Out

Fertilizer Applications:
2002: September – 200 lbs/ac of ammonium phosphate
2003: March --- 200 lbs/ac of urea, June --- 150lbs/ac of urea
2004: March --- 100 lbs/ac of urea

Table 8
Forage Quality (CP) at Tucson Plant Materials Center

DATE (CP %)		'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	Big sacaton	'Vaughn' sideoats grama	'Tango' prairie brome grass
2001	**CP**	N/A	17.5	13.8	14.4	N/A	N/A	N/A	N/A
2002	**CP**	14.9	12.4	16.5	11.8	7.2	N/A	9.6	15.2
2003	**CP**	15.7	17.7	19.9	22.1	16.9	18.2	19.3	Out
2004	**CP**	16.5	16.6	15.9	15.2	11.8	10.9	8.7	Out

Sample Dates:
2001: (August14), 2002: (August 1 for 'Jesup' and 'Tango') and (September 6 for warm season grasses), 2003: (June 6), 2004: (June 8)

Table 9
Forage Quality (TDN) at Tucson Plant Materials Center

DATE (TDN %)		'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	Big sacaton	'Vaughn' sideoats grama	'Tango' prairie brome grass
2001	**TDN**	N/A	64.5	67.8	65.6	N/A	N/A	N/A	N/A
2002	**TDN**	62.8	56.4	59.3	56.6	51.5	N/A	52.6	61.0
2003	**TDN**	67.0	63.0	77.0	66.9	58.5	58.3	58.5	Out
2004	**TDN**	60.4	61.3	55.9	63.2	59.8	57.8	57.7	Out

Sample Dates:
2001: (August14), 2002: (August 1 for Jesup and Tango) and (September 6 for warm season grasses), 2003: (June 6), 2004: (June 8)

Table 10
Water Use Efficiency (WUE) at Tucson Plant Materials Center

DATE WUE		'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	Big sacaton	'Vaughn' sideoats grama	'Tango' prairie brome grass
2001	**WUE**	N/A	64.5	67.8	65.6	N/A	N/A	N/A	N/A
2002	**WUE**	32.2	120.8	88.6	165.7	158.4	N/A	361.5	31.5
2003	**WUE**	85.3	227.6	221.2	268.6	173.9	335.5	282.8	Out
2004	**WUE**	88.1	181.9	192.3	221.2	131.9	279.8	371.2	Out

Table 11
Irrigation Water Applied (in) at Tucson Plant Materials Center

DATE	'Jesup' tall fescue	'Cheyenne' bermuda grass	Common bermuda grass	Giant bermuda grass	'Loetta' Arizona cottontop	Big sacaton	Vaughn sideoats grama	'Tango' prairie brome grass
2001	28.6	74.5	79.0	91.7	39.2	N/A	38.2	32
2002	83.6	98	96.2	89.4	52.5	N/A	43.3	61.8
2003	100.8	77.9	77	71	59.8	45.8	56.7	Out
2004	93.9	84.7	87	73.3	57.7	43.5	41.2	Out