TITLE:

West Texas Peanut Nutrition—*Rhizobium* and Nitrogen (TPPB)

AUTHOR:

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OBJECTIVE:

Much of the past data from nitrogen studies in West Texas peanut has been inconclusive about the yield benefits to peanut. Unfortunately, two important pieces of information are missing from past peanut nitrogen work in West Texas: 1) no measure of soil nitrogen was recorded (there is a potential buildup of N from over-fertilization of cotton), and 2) there is no record of observations of the degree of *Rhizobium* nodulation. Field observations continue to suggest that as much as 25% of West Texas peanut fields may be undernodulated.

The objective is to conduct a combination of Rhizobium *inoculation treatments and N fertilizer treatments (amount and timing) on typical and caliche soils to ascertain the comparative importance of good nodulation and N fertilizer on yield.*

METHODS AND PROCEDURES:

The following trials were conducted at the Western Peanut Growers Assn. research farm in north central Gaines Co., Texas.

	Gaines County **Normal Soil**	Gaines County **Caliche Soil**
Soil Type:	Brownfield loamy sand	Brownfield loamy sand
Peanut variety:	Flavor Runner 458	Flavor Runner 458
Planting:	May 10, 2001, on 36” rows	May 2, 2001 on 36” rows
Previous Crop:	Cotton	Cotton
Seeding Rate:	~4.5 seeds per row foot	~4.5 seeds per row foot
Plot Set-up:	RCBD, four reps each treatment	Same
Harvest Area:	4 rows X 52.5’	4 rows X 52.5’
Inoculant:	Numerous—see tables (includes liquid, granular frozen at 0X, 1X, & 2X rates)	
N Fertilizer:	Numerous—see tables (include 0, 20, 100 lbs. N/A with different timing)	
Herbicide:	Sonolan	Sonolan
Insecticide:	None	None
Rainfall:	~3.6” during the growing season	3.0” during growing season
Irrigation level:	~21”	~19”
Soil test NO3:	0-8”, 14 ppm (low); 8-36”, 6 ppm (low)	0-8”, 12 ppm (low); 8-36”, 8 ppm (low)
Soil pH:	7.5	8.0
Date Dug:	October 26, 2001	~October 19, 2001
Date Harvested:	November 5, 2001	November 1-2, 2001

All fertilizer applications were conducted with hand broadcast urea on to dry soil, and watering occurred within 3 to 20 hours. Liquid tanks on the tractor were well cleaned between using different inoculants. *Rhizobium* nodules counts were collected at approximately one-month intervals for the ‘normal’ soil site. Plots were harvested with a small plot combine.

RESULTS AND DISCUSSION:

“Nornal” Site (non-caliche)

Due to the later planting date and trouble with irrigation capacity, yields were lower than hoped for. Higher yield potential is required to test these ideas at yields similar to farmers’ expectations in Gaines County and surrounding area. Much of the *Rhizobium* nodule count data (Table 1) is an effort of the NPB-funded *Rhizobium* activity project, and is discussed there. In brief I note that a high rate of at-plant broadcast N fertilizer harmed nodulation. Nodulation response to double rate inoculant was mixed (Tables 2 and 3). Urbana FrozenPrep inoculant did not nodulate as well, but I lack other sites for comparison other than Western Peanut Growers Farm in 2001. (In 2002 this product, which has the same inoculant strains, will be compared to Urbana’s conventional liquid inoculant to see if the ‘frozen’ process reduces *Rhizobium* viability.

Table 1. *Rhizobium* nodule counts (12 plants per plot) on selected plots through the season for a non-caliche soil. Plants were removed from just outside the harvest area so as not to limit yield. Western Peanut Growers Farm, Gaines Co., TX.

Rhizobium product and rate	At planting Nitrogen Rate	Average nodules per plant at counting date (*% of plants with 0 or 1 nodules*)		(*% w/ 0-5 nodules*)	Treatment
	-- lbs. N/A --	June 19	July 12	August 14	
None	None	0.7 (*85*)	1.2 (*54*)	1.6 (92)	2
None	100	0.1 (*72*)	0.1 (*77*)	0.4 (*100*)	5
Urbana granular 1X	20	3.7 (*34*)	4.8 (*10*)	8.6 (*45*)	6
Urbana granular 2X	20	4.7 (*34*)	9.0 (*10*)	14.7 (*25*)	8
Liquid Lift 1X	20	10.3 (*35*)	12.8 (*21*)	22.7 (*25*)	10
Liquid Lift 1X	100	2.8 (*60*)	3.0 (*65*)	5.4 (*73*)	13
Liquid Lift 2X	20	13.8 (*4*)	19.3 (*8*)	28.4 (*13*)	14
Liquid Lift 2X	100	9.2 (*33*)	6.5 (*40*)	7.2 (*66*)	17
Urbana Frozen 1X	20	2.3 (*40*)	3.0 (*46*)	9.2 (*56*)	18
Urbana Frozen 2X	20	4.9 (*33*)	6.8 (*25*)	9.8 (*47*)	20
Lift 1X/Urb. Gran. 1X	20	7.6 (*19*)	14.0 (*9*)	23.3 (*15*)	23

Visual observations on the WPG normal soil site began to show N deficiency in late June. It was easiest to pick out plots that had received no N fertilizer. As the season progressed, inoculated treatments without added N were visually more N deficient than uninoculated plants receiving N. Furthermore, treatments that were inoculated but received no N were in some cases undernodulated (e.g., Urbana FrozenPrep). Treatment yield means were highly significant in their differences (Table 2).

Table 2. Summary of runner peanut yields due to *Rhizobium* inoculant and rates by N fertilizer rates and timing for a non-caliche soil at Western Peanut Growers Farm, Gaines Co.

Treat-ment	*Rhizobium*	Rhiz Rate	Early season N (lbs./A)	Mid-season N (lbs./A)	Aug. 14 Avg. nodules per plant	Average yield (lbs./A)^	Grade % (SMK+SS)
1	None	0X	0	0		2023 j	73.2
2	None	0X	20	0	1.6	2352 ij	74.8
3	None	0X	20	80		3283 c-g	75.0
4	None	0X	20	4x20		3468 b-f	74.5
5	None	0X	100	0	0.4	3027 d-h	74.0
6	Urbana granular	1X	20	0	8.6	2746 g-I	74.2
7	Urbana granular	1X	20	80		3118 c-g	75.1
8	Urbana granular	2X	20	0	14.7	2508 h-j	73.9
9	Urbana granular	2X	20	80		3534 a-e	75.2
10	Lift liquid	1X	20	0	22.7	2986 e-h	75.0
11	Lift liquid	1X	20	80		3648 a-c	74.3
12	Lift liquid	1X	20	4x20		3882 ab	74.0
13	Lift liquid	1X	100	0	5.4	3200 c-g	73.8
14	Lift liquid	2X	20	0	28.4	3202 c-g	74.0
15	Lift liquid	2X	20	80		3902 ab	73.8
16	Lift liquid	2X	20	4x20		4093 a	74.4
17	Lift liquid	2X	100	0	7.2	3105 c-g	75.6
18	Urbana frozen	1X	20	0	9.2	2468 h-j	76.2
19	Urbana frozen	1X	20	80		3498 b-f	75.0
20	Urbana frozen	2X	20	0	9.8	2526 h-j	73.1
21	Urbana frozen	2X	20	80		3581 a-d	73.5
22	Lift liquid	1X	0	0		2681 g-I	74.2
23	Lift/Granular	1X/1X	20	0	23.3	2940 f-h	74.6
Trial average yield						3121	
Coefficient of Variation (CV)						20.2%	
P-value						<0.0001	
Least Significant Difference (LSD), 0.05						572	

^Yields followed by the same letter are not significantly different at the 0.05 level.

The best way to examine the effects of treatments may be to combine inoculant or N rates to focus on *Rhizobium* and N fertility comparisons. Table 3 summarizes the comparisons among inoculant rate by N (section A), N rate at any inoculant or rate (section B), and mid-season N for any inoculant or rate (section C). Even at these lower yields, N rates of 100 lbs./A has significant effect on yields (from near 1000 lbs./A with no inoculant to about 400 lbs./A if inoculated). The addition of 80 lbs. of N mid-season N returned about 925 lbs./A yield, or an economic return of near $135/A in this trial. This is in contrast to much previous work in peanuts in West Texas where it has been difficult to show yield response to N. Certainly this site at WPG was not supernodulated with *Rhizobium* nor did it have any major accumulation of subsoil N (about 50 lbs. N/A in the top 3').

Application of 100 lbs. of broadcast N at planting was inferior to mid-season N (504 lbs./A more yield). At planting N placed in the root zone with a knife rig will probably yield better, and might be more comparable to mid-season N applications. Lastly, a 203 lbs./A yield increase was observed by splitting the 80 lbs. N/A applied mid-season into four 20 lb. applications (Table 3). This was not substantially different, but is point worth further examination as many producers may apply N through the pivot with little application cost.

Table 3. Summary of yield effects of for inoculant rate (0X, 1X, 2X) or N amount or timing (at any inoculant) to elucidate effects of different treatments on a non-caliche field. Western Peanut Grower Farm, Gaines County, TX.

A) N treatments separated by inoculant rate^	# of treatments	Avg. yield (lbs./A)
0X, 0N	1	2024
0X, 20N	1	2352
0X, 100N	1	3027
0X, 20/80N	2	3376
1X, 20N	3	2734
1X., 100N	1	3200
1X, 20/80N	3	3421
2X, 20N	3	2745
2X, 20/80N	3	3672

B) N treatments for any inoculant at all rates	# of treatments	Avg. yield (lbs./A)
20N	6	2740
100N	2	3153
20/80N	8	3657

C) Mid-season N treatments for any inoculant at all rates	# of treatments	Avg. yield (lbs./A)
80N	3	3611
4x20N*	3	3814

^20/80 N rate is 20 lbs. N/A at planting with 80 lbs. N/A mid season.
*4X20N is the application of mid-season N increments when combined equals the 80 lbs. N/A mid-season rate. This treatment attempts to mimic multiple N applications through the pivot.

"Caliche" Site

Caliche soils due to their higher pH are primed for reduced *Rhizobium* nodulation and activity. The trial on a strongly caliche are of the WPG farm seeks to observed any differences in peanut yield response to *Rhizobium* or N fertilizer compared to a more conventional site (Tables 1 to 3). The nature of this test site, however, was more of large caliche fragments rather than finely ground caliche which gives the soil a whitish cast.

Unfortunately, a labeling mistake in handling nodule count samples co-opted the nodule collections on August 14, 2001. Table 4 contains the June 6 nodule counts. Nodule counts at double rates were slightly better except for Urbana FrozenPrep, which was essentially the same as the uninoculated control. Late season observations indicated that Urbana FrozenPrep did eventually nodulate, but not as much as Lift. Yields for Urbana FrozenPrep and Lift were comparable, and were generally about 300 lbs./A better than granular inoculant.

Treatments were highly significantly different among *Rhizobium* and N (Table 4). In spite of the caliche soil, and damage from an early cold wind on May 25th this site, planted 8 days earlier than the 'normal' site detailed in Tables 1 to 3, yielded about 600 lbs./A more.

Table 4. Summary of runner peanut yields due to *Rhizobium* inoculant and rates by N fertilizer rates and timing for a caliche soil at Western Peanut Growers Farm, Gaines Co.

Treat-ment	*Rhizobium*	Rhiz Rate	Early season N (lbs./A)	Mid-season N (lbs./A)	June 6 Avg. nodules per plant	Average yield (lbs./A)^	Grade % (SMK+SS)
1	None	0X	0	0		3247 f-h	74.8
2	None	0X	20	0	0.4	3406 e-h	73.6
3	None	0X	20	80		4067 a-e	73.7
4	None	0X	20	4x20		4132 a-d	73.6
5	None	0X	100	0	0.9	3066 gh	75.7
6	Urbana granular	1X	20	0	3.0	3663 c-g	74.9
7	Urbana granular	1X	20	80		3896 a-f	74.5
8	Urbana granular	2X	20	0	4.3	3579 c-g	73.6
9	Urbana granular	2X	20	80		3747 b-f	74.4
10	Lift liquid	1X	20	0	2.8	3666 c-g	74.0
11	Lift liquid	1X	20	80		4026 a-e	75.1
12	Lift liquid	1X	20	4x20		3920 a-e	77.4
13	Lift liquid	1X	100	0	0.4	2838 h	74.5
14	Lift liquid	2X	20	0	7.1	3812 a-f	75.5
15	Lift liquid	2X	20	80		4194 a-c	74.7
16	Lift liquid	2X	20	4x20		4123 a-d	75.5
17	Lift liquid	2X	100	0	3.1	3665 c-g	74.9
18	Urbana frozen	1X	20	0	0.4	3544 d-g	75.9
19	Urbana frozen	1X	20	80		4380 ab	75.3
20	Urbana frozen	2X	20	0	0.2	3655 c-g	73.1
21	Urbana frozen	2X	20	80		4418 a	73.4
Trial average yield						3764	
Coefficient of Variation (CV)						14.4%	
P-value						0.0005	
Least Significant Difference (LSD), 0.05						668*	

^Yields followed by the same letter are not significantly different at the 0.05 level.

*LSD comparing most treatments with four reps.; some pairwise comparisons had higher LSD due to loss of individual replicates.

Similar to Table 3, a summary of treatment effects for *Rhizobium* rate and N rate and timing demonstrates the 'bottom line' on practical results for farmers. In Table 5, section A, we note a similar response, about 800 lbs./A for 100 lbs./AN applications over 0 N with no inoculant, to about 400 lbs/A if inoculated. At plant N rates of 100 lbs./A actually reduced yields because the stands were thinned in the caliche soil (Table 5, sections A and B). *Rhizobium* inoculant contributed minimally (100 to 200 lbs./A)to any yield improvement over uninoculated treatments (Table 5, section A).

Because of the reduction in plant stand comparison of the mid-season N applications of 80 lbs. N/A vs. putting the fertilizer out at planting are not valid. Again, knifing the fertilizer into the soil should have precluded the reduction in plant stand.

Finally, no difference was observed on the caliche site in splitting the mid-season N into four 20 lb. N applications.

Table 5. Summary of yield effects of for inoculant rate (0X, 1X, 2X) or N amount or timing (at any inoculant) to elucidate effects of different treatments on a caliche soil. Western Peanut Grower Farm, Gaines County, TX.

A) N treatments separated by inoculant rate^	# of treatments	Avg. yield (lbs./A)
0X, 0N	1	3247
0X, 20N	1	3406
0X, 100N	1	3066
0X, 20/80N	2	4099
1X, 20N	3	3624
1X, 100N	1	2838
1X, 20/80N	3	4101
2X, 20N	3	3738
2X, 20/80N	3	4120

B) N treatments for any inoculant at all rates	# of treatments	Avg. yield (lbs./A)
20N	6	3653
100N	2	3251
20/80N	8	4088

C) Mid-season N treatments for any inoculant at all rates	# of treatments	Avg. yield (lbs./A)
80N	3	4096
4x20N*	3	4058

^20/80 N rate is 20 lbs. N/A at planting with 80 lbs. N/A mid season.
*4X20N is the application of mid-season N increments when combined equals the 80 lbs. N/A mid-season rate. This treatment attempts to mimic multiple N applications through the pivot.

This work was funded by the Texas Peanut Producers Board. More information on peanuts in the Texas South Plains, visit the website of the Texas A&M Center , Lubbock, at http://lubbock.tamu.edu