Comparison of Agricultural and Power Plant By-Product Gypsum for South Texas Peanut Production

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ABSTRACT

Field studies were conducted in 1998 and 1999 at one location in Atascosa and two locations in Wilson County to evaluate the effects of power plant by-product gypsum in comparison with agricultural gypsum applied to peanuts at planting or pegging. The Atascosa County site contained moderate to high calcium (Ca) levels while the Wilson County site was low to moderate in Ca. No differences in southern blight, *Rhizoctonia* pod rot disease control, peanut yield, or grade were noted with each gypsum source. Gypsum reduced disease development at two of three locations but only increased peanut yield or grade at one of three locations.

KEYWORDS: *Arachis hypogaea*, groundnut, *Rhizoctonia solani*, *Sclerotium rolfsii*, southern blight, yield, quality.

High yielding and good quality peanuts (*Arachis hypogaea* L.) require adequate calcium (Ca) in the top 3 in. of the soil during pegging and pod filling. Calcium supplements are frequently required to maintain development. For many years gypsum has been the dominant material used as a Ca supplement for peanuts; although alternative materials have been tested and used by growers on a limited basis. Gypsum has a relatively high solubility and therefore is quickly available to plants. Because gypsum is a neutral salt, it does not increase soil pH.

In runner and Virginia type peanuts calcium is by far the most critical nutrient for achieving high yields and grades. Low levels of calcium cause several serious production problems, including unfilled pods (pops), darkened plumules in the seed and poor germination. Virginia types are less able to take up adequate Ca than runner and Spanish types. This may simply be a matter of pod size, since there is less surface area on larger pods per unit weight of nut (Cox and Sholar 1995). For runner peanut, the critical level is 300 to 500 pounds of Ca per acre while preliminary results with Virginia type peanuts indicate that the critical level should be at least 1500 pounds of Ca per acre (Cox and Sholar 1995).

Since gypsum is a relatively soluble source of Ca (York and Colwell 1951), it is subject to almost complete loss from the soil surface by the time peanuts are harvested (Jones et al. 1976). To offset the leaching loss from the primary pegging zone, gypsum may be applied at planting or pegging to insure that adequate Ca is present in the pegging zone for pod development.

Peanut yields are often limited by a lack of Ca in the fruiting zone (Taylor and Moshrefi 1987). Calcium is passively absorbed and transported almost exclusively in xylem tissue and moves with the transpiration stream. The relationship between Ca and yield occurs as a result of the lack of Ca movement in the developing peg via the phloem. The developing fruit, consequently, depends upon the presence of adequate Ca in the soil solution (Skeleton and Shear 1971, Slack and Morrill 1972).

Another advantage of gypsum would be to aid in the digging process by reducing clod size and improve shedding of soil from peanuts planted in a heavy textured soil (authors personal observation). The reduced cost of by-product gypsum should be an advantage for producers on soils low in Ca and/or S.

Alternative sources of gypsum from power plants have recently come on the market and producers have voiced concerns about heavy metals and other contaminants in addition to plant response to these products. The objective of this study was to compare the effects of power plant by-product gypsum with regular agricultural gypsum on disease development, peanut yield and quality.

MATERIALS AND METHODS

Field studies were conducted during the 1998 and 1999 growing season at one location in Atascosa and two locations in Wilson County to determine the effects of gypsum upon peanut quality and yield.

The location in Wilson County historically had moderate to heavy incidence of the soil-borne disease *Rhizoctonia* pod rot (*Rhizoctonia solani* Kuhn) and pythium pod rot (*Pythium myriotylum*). The Atascosa County location consisted of the soil-borne disease *Rhizoctonia*, southern blight (*Sclerotium rolfsii* Sacc.) and sclerotinia blight caused by *Sclerotium minor* Jagger. Agricultural gypsum obtained from a local distributor[1] was compared with gypsum obtained as a by-product[2] of a coal-generated power plant located near LaGrange, TX. Representative samples of agricultural gypsum and by-product gypsum were collected prior to study initiation and submitted to the Texas Agricultural Extension Service Soil Testing Laboratory for chemical analysis. Soils at the Atascosa County location were a Duval loamy fine sand (fine-loamy, mixed, hyperthermic Aridic Haplustalfs) with < 1% organic matter and a pH of 7.2.

Soils at the Wilson County location were a Miguel fine sandy loam (fine, mixed, hyperthermic Udic Paleustalfs) with 1.5% organic matter and a pH of 7.0. Initial Ca levels at the Wilson County location were intermediate while Ca levels at Atascosa County were high.

'GK-7' peanut variety was planted at all locations during late May or early June. Peanuts were planted using a vacuum planter[3] set to plant seed 2 in. deep at rate of 80 lbs/ac.

Gypsum was hand applied to plots prior to planting and approximately 60 d after planting when peanut had begun to peg. The gypsum for each plot was pre-weighed, spread over the peanut row (at plant) or spread over the top of the peanut plant within the pegging zone (peg). Irrigation was applied within 5 days of the pegging application to move the gypsum into the pegging zone.

[1]Hoe-Down, Standard Gypsum Corp., 1650 Gypsum Mine Rd., Fredericksburg, TX 78624.
[2]Boral Material Technologies, Inc., San Antonio, TX 78216.
[3]Monosem pneumatic planter, A.T.I., Inc. Leneka, KS 66219.

Plot size was 4 rows 12 ft wide by 30 ft long. The treatment design was a randomized complete block with four replications. Gypsum treatments included by-product gypsum at 500, 1000,1500, and 2000 lbs/ac applied at planting or 1000 and 2000 lbs/ac applied at pegging. Agricultural gypsum at 1000, 1500, and 2000 lbs/ac was applied at plant or 1000 and 1500 lbs/ac was applied at pegging. An untreated check was included for comparison.

Treatment response data were obtained from the middle two rows of each plot to eliminate edge effects from adjacent plots. Yields were obtained by digging each plot separately, air-drying in the field for 5 to 8 d, and harvesting peanut pods with a tractor pulled combine. Weights were recorded after soil and foreign material were removed from plot samples. Peanut grades were determined from a 7 oz pod sample from each plot following procedures described by the Federal-State Inspection Service (USDA 1998).

Disease incidence were counted immediately after digging. Infection sites (hits) were determined by discolored pods with visual confirmation of the fungus by mycelia or sclerotia production (Rodriguez-Kabana et al. 1975). Maximum length for a target site, if no healthy stems intervened was 12 in. Differences between adjacent infection sites was based on the presence of apparently healthy intervening stems. Since total plot length was 50 ft. (2 row by 25 ft. long), percent disease was determined by dividing the total number of disease sites by 50.

Disease incidence along with peanut yield and grade were evaluated using analysis of variance. Since there was a treatment by location interaction for peanut yield, grade, and disease, the data are presented separately by location. Means were separated using Fisher's Protected LSD test at the 5% level.

RESULTS AND DISCUSSION

Gypsum composition. Chemical analysis of the two gypsum sources indicated that by-product gypsum contained greater concentrations of boron, chloride, magnesium, potassium, and sodium (Table 1). Concentrations of Ca and S were similar for the two products, thus any differences in plant uptake likely would be attributed to variations in solubility. Moisture levels were higher in by-product gypsum compared to agricultural gypsum.

Table 1. Chemical composition of by-product gypsum and agricultural gypsum.

Component	By-product gypsum	Agricultural gypsum
	----------ppm----------	
Aluminum	< 0.05	< 0.05
Arsenic	< 0.01	< 0.01
Barium	0.09	0.06
Boron	0.25	0.12
Calcium	590.0	570.0
Cadmium	< 0.005	< 0.005
Chromium	< 0.01	< 0.01
Copper	< 0.02	< 0.02
Iron	< 0.02	< 0.02
Lead	< 0.005	< 0.005
Magnesium	12.0	< 0.5
Manganese	< 0.01	0.01

Table 1. (Cont'd.)

Component	By-product gypsum	Agricultural gypsum
	---ppm---	
Mercury	< 0.0002	< 0.0002
Molybdenum	< 0.02	< 0.02
Nickel	< 0.02	< 0.02
Phosphorus	< 1.0	< 1.0
Potassium	3.7	< 1.0
Selenium	< 0.01	< 0.01
Silver	< 0.01	< 0.01
Sodium	41.0	0.92
Vanadium	< 0.02	< 0.02
Zinc	0.06	0.1
Chloride	40.0	< 1.0
Sulfate	1580.0	1500.0
Sulfur (%)	14.3	16.3
pH	7.3	8.0
Moisture (%)	20.0	1.0

Disease development. In 1998, in Wilson County, all gypsum rates except for the by-product gypsum at 500 lbs/ac applied at plant decreased disease development up to 50% when compared with the untreated check (Table 2). Other studies have noted a decrease in pythium disease development when gypsum has been applied. Garren (1964) first reported that high rates of gypsum resulted in a reduction of rotted peanut pods. Walker and Csinos (1980) stated that under severe disease pressure with several cultivars, disease decreased for all cultivars as the rate of gypsum applied was increased.

Table 2. Percent disease development after peanuts were inverted at each location.

			Location[a,b]		
			1998		1999
Treatment	Rate (lbs/ac)	Application timing	---%---		
			Atascosa Co.	Wilson Co.	Wilson Co.
Check	-		28	28	20
By-product gypsum	500	plant	30	25	8
	1000	plant	30	18	14
	1500	plant	22	16	10
	2000	plant	24	14	12
	1000	peg	23	18	10
	1500	peg	27	11	15
Ag gypsum	1000	plant	29	19	9
	1500	plant	34	19	10
	2000	plant	37	17	11
	1000	peg	28	15	13
	1500	peg	31	16	12
LSD (0.05)			11	6	9

[a]Disease incidence in Wilson County was 70% Rhizoctonia pod rot and 30% pythium pod rot.
[b]Disease incidence in Atascosa County was 50% southern blight, 40% Rhizoctonia pod and limb rot, and 10% scelrotinia blight.

At the Atascosa County location, no difference in disease incidence was noted between the untreated check and any gypsum treatment (Table 2). Since at this location the primary disease was southern blight, it was hypothesized that no response to gypsum would be noted in disease development (authors personal opinion). However, there have been reports that high levels of Ca may control the pathogen that causes southern blight or that added Ca may increase resistance or productivity of the host plant (Garren and Jackson 1973, Watkins 1961).

In 1999, by-product gypsum at 500 and 1500 lbs/ac applied at plant or 1000 lbs/ac applied at peg and agricultural gypsum at 1000, 1500, and 2000 lbs/ac applied at planting reduced disease incidence (Table 2). Other studies have shown that the readily soluble Ca requires high rates of gypsum be applied to insure adequate Ca was present in the pegging zone for pod development (Jones et al. 1976).

Peanut yield. No increase in peanut yield over the untreated check was noted in either location in 1998 (Table 3). However, in 1999, by-product gypsum at 2000 lbs/ac applied at planting and agricultural gypsum at 1500 and 2000 lbs/ac applied at planting increased peanut yield up to 22% over the untreated check. On light textured soils low in residual Ca, peanut yields have been increased with gypsum applications (Walker and Csinos 1980, Sullivan et al. 1974).

Table 3. Peanut yield with by-product and agricultural gypsum.

			Location[a,b]		
			1998		1999
Treatment	Rate (lbs/ac)	Application timing	--------%--------		
			Atascosa Co.	Wilson Co.	Wilson Co.
Check	-		4195	2654	3325
By-product gypsum	500	plant	4164	3227	3768
	1000	plant	4100	3037	3358
	1500	plant	3946	3016	3783
	2000	plant	4053	3324	3859
	1000	peg	4160	2404	3590
	1500	peg	4363	3008	3456
Ag gypsum	1000	plant	4015	3213	3804
	1500	plant	4011	3042	4011
	2000	plant	3786	3222	4044
	1000	peg	4264	2890	3582
	1500	peg	4102	2913	3619
LSD (0.05)			415	721	514

Peanut Grade. Only in 1998 at the Wilson County location was a significant grade increase noted over the untreated check (Table 4). By-product gypsum at 1500 lbs/ac applied at plant or agricultural gypsum at 1000 lbs/ac applied at peg did not increase peanut grade over the untreated check. Other studies have also reported varying results. Walker and Keisling (1978) reported that gypsum applications did not increase Florunner grade even when residual soil Ca was low while other cultivars responded with higher grades when gypsum was applied. Gascho et al. (1993) found that limestone applied prior to planting was an excellent source of Ca and increased peanut grade.

Table 4. Percent peanut grade with by-product and agricultural gypsum[a].

Treatment	Rate (lbs/ac)	Application timing	Location[a,b]		
			1998		1999
			---------------%---------------		
			Atascosa Co.	Wilson Co.	Wilson Co.
Check	-		75	65	76
By-product gypsum	500	plant	74	72	77
	1000	plant	74	73	75
	1500	plant	74	69	77
	2000	plant	75	73	76
	1000	peg	74	72	74
	1500	peg	74	72	77
Ag gypsum	1000	plant	76	73	77
	1500	plant	75	73	75
	2000	plant	75	71	77
	1000	peg	74	69	76
	1500	peg	74	72	76
LSD (0.05)			3	2	2

[a]Grade = sound mature kernel and sound splits.

In conclusion, the addition of Ca in the form of by-product or agricultural gypsum was effective for reducing incidence of Rhizoctonia and pythium pod rot. However, peanut yield and grade response was variable and this may be more of a cultivar response.

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