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Effect of Three Ca Sources Applied On Peanuts I. Productivity and Seed Quality[1]

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ABSTRACT

The relative effectiveness of United States Gypsum granular 420 Landplaster Bulk (420-Bulk) and Texasgulf Gypsum (Tg Gypsum) were compared with finely ground anhydrite (Bagged-LP) as sources of supplemental Ca for Florigiant peanuts (*Arachis hypogaea* L.). Treatments included the above sources at rates of 605 kg/ha banded (61 cm) or 907 kg/ha broadcast (91-cm wide rows) of $CaSO_4$ equivalent per unit area covered (double these rates of 420-Bulk and Bagged-LP also were applied in 1977). Times of application were planting, planting + ca 30 days, and early flowering stage. The experiments were located on Kenansville lfs (Arenic Hapludult) in 1977 and on Rumford lfs (Typic Hapludult) in 1978.

The Ca treatments increased crop yields from 360 to 1,200 kg/ha and crop value (yield x price) from $343 to $889/ha over the check in 1977. Slightly lower yield increases were obtained in 1978 when dry conditions prevailed during fruit maturation. Kernel size grades were improved markedly by all Ca treatments in 1977. There was a definite trend both years (significant in 1978) toward higher productivity when the Ca sources were applied at the early flowering stage compared to earlier applications. No difference was noted between methods of application of Bagged-LP or Tg Gypsum in 1978. Double rates of Bagged-LP or 420-Bulk in 1977 did not increase productivity over the low rates. A single application of Bagged-LP was as effective as split applications in the 1978 test.

Germinability of seed in 1977 averaged 85% or higher for all Ca treatments. Seed germination in 1978 averaged 75%, 69% and 74% in plots where Tg Gypsum, 420-Bulk or Bagged-LP was applied, respectively. Germination was lowest in the check plots both years. Germinability and seed-Ca contents were significantly higher in 1978 when the Ca sources were applied at the early flowering stage (ca July 1) than 15 days earlier.

Seed-Ca contents both years and K contents in 1978 were significantly correlated with germinability. The correlation coefficients were only 0.4 in each case and the relationship was negative for K.

In general, 420-Bulk, Tg Gypsum, or Bagged-LP were equally effective sources of supplemental Ca for peanuts. However, when fruit mature under very dry conditions 420-Bulk may be somewhat inferior to the other Ca sources especially when applied before early flowering.

Key Words: *Arachis hypogaea* L., Groundnuts, Landplaster, Gypsum, Anhydrite, Seed mineral contents.

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[3]Mention of particular corporations or trade names does not infer endorsement or preference by Va. Polytech. Inst. and S. U. of any products listed.

Producers of large-seeded Virginia-type peanuts (*Arachis hypogaea* L.) normally apply Ca to promote better fruit development. Thirty years ago, Bledsoe, et al. (1) demonstrated that peanut fruits must absorb the Ca necessary for proper development from the growth medium. Previously, Colwell and Brady (3) had reported responses by large-seeded peanuts to supplemental Ca applied soon after early flowering. More recently, in addition to increased yields, other benefits have been found from the application of supplemental Ca, Hallock and Garren (9) reported that landplaster ($CaSO^4$) may decrease losses from pod breakdown disease when it is prevalent and effectively counteract the disease enhancement effect of high soil K levels. Dark plumule and watery hypocotyl abnormalities in seed have also been related to Ca deficiency (4, 10, 15). Sullivan, et al. (15) and Cox, et al. (5) reported that germination and other seed qualities frequently were improved by supplemental Ca applications. Walker and Keisling (17) reported that gypsum applications to soils low in Ca but with a high pH increased seed oil content in several peanut cultivars. In view of these effects, it is likely that the use of supplemental Ca on large-seeded peanuts will continue. However, Hartzog and Adams (11) obtained a predictable yield response to extra Ca only when the dilute acid-extractable Ca level in Alabama soils was below 224 kg/ha, a level considerably below that indicated by similar analytical procedures in most Virginia peanut fields.

Finely ground landplaster was the principal supplemental Ca source used for peanuts in Virginia for many years. Recent production methodology necessitated development of Ca sources that could be bulk-spread more effectively than finely ground landlaster (Bagged-LP). Two materials were adapted for bulk-spreading. The United States Gypsum Company[3] developed a granular landplaster now called 420 Landplaster Bulk (420-Bulk) and Texasgulf, Inc. merchandised a gypsum by-product (Tg Gypsum) from their phosphate processing operations. This by-product is known by several names: Texasgulf Gypsum, Tg Gypsum, Phosphogypsum, or Wet Landplaster.

The relative effectiveness of Bagged-LP, 420-Bulk, and Tg Gypsum were compared in field experiments conducted in 1977 and 1978. The effects of rates and times of application on peanut productivity are presented in this paper. The effects of these treatments on contents of Ca, Mg, and K in the peanut fruiting zone and immediately below during fruit development are given in a companion paper (8).

Materials and Methods

This research was conducted on private farm fields located in Southampton County, Virginia. Florigiant peanuts were grown on Kenansville lfs (Arenic Hapludult) in 1977 and on Rumford lfs (Typic Hapludult) in 1978. Soybeans had been grown the previous year on the Kenansville site and corn on the Rumford site. No P or K was applied directly for peanuts, but the previous crop had been fertilized with approximately 35 kg/ha of P and 135 kg/ha of K. Boron was sprayed on the peanut foliage at a rate of 0.56 kg/ha at the early fruiting stage (ca 70 days post-planting).

Seed treated with DCNA-Captan were machine-planted approximately 10 cm apart in the middle of beds 61 cm wide and ca 7.5 cm high. Planting dates were 2 May, 1977 and 18 May, 1978. Plots were four rows (91 cm) wide by 12.2 m long with treatments arranged in a completely randomized block design with three replications. Pesticides applied according to Virginia recommendations each year (16) were Vernolate, Alachlor, Dyanap, Diphenamid, Carbofuran, Aldicarb, Benomyl, Manzate 200, and Chlorothalonil. Dicofol and Methomyl also were applied in 1977, and flowable S and Dicloran in 1978. The plots were cultivated once each year during early flowering stage.

All observations and measurements were made utilizing peanuts from the two center rows of each plot. The peanuts were dug in late September each year and allowed to cure in the field for 5 days or more before combining. The partially dried fruits were further dried artifically to ca 8% moisture and weighed for yield determinations. Fruit samples (500 g) from each plot were graded according to standards set forth by the Fresh Products Standardization and Inspection Branch, Fruit and Vegetable Division, USDA. Extra large kernels are undamaged seed which ride an 0.85- by 2.54-cm screen and sound mature kernels are those undamaged seed which ride a 0.60- by 2.54-cm screen. Seed passing through both screens are called other kernels. The price per unit weight of peanuts was calculated for each plot according to the USDA peanut support price schedule for Virginia type farmer's stock peanuts for 1977 and 1978. Crop value per ha = price per unit weight x yield per ha.

Soil samples of the plow layer obtained from each plot area prior to treatment were analyzed for pH and contents of available P, K, Ca, Mg, Mn, and Zn by rapid soil testing procedures (7). Samples of sound mature kernels were finely chopped in a stainless steel blender and dried at 70 C. Samples (1 g) of kernels were ashed at 450 C for 2.5 to 3 hours and the inorganic nutrient constituents of the ash dissolved in 25 ml of 0.5 N HCl. Contents of K in solution were determined by flame emission and contents of Ca, Mg, Mn, Zn, and Cu by atomic absorption spectrophotometry. Phosphorus was determined by an ammonium vanadate procedure (12). Estimation of seed germinability was made by placing 50 sound mature seed in a Seedboro Model 300 Germinator set at 27 C. The seed were dusted with DCNA-Captan to preclude fungal infection and with Ethephon to eliminate dormancy. Seed which had not produced hypocotyls longer than 1 cm after 10 days in the germinator were considered non-viable. Seed samples for analysis and germinability were taken from the same lots.

The Ca-sources applied in 1977 and 1978 were regular bagged landplaster (Bagged-LP), 420 Landplaster-Bulk (420-Bulk), and Texasgulf Gypsum (Tg Gypsum) which contained ca 15% free water. The 1978 experiment included Tg Gypsum which had been dried to ca 3% free water before application. Approximate particle sizes of these materials were as follows: Bagged-LP had 14% > 150 μm, 64% < 75 μm, 420-Bulk had 2% > 4.75 mm, 80% >850 μm, and 8% <150 μm, Tg Gypsum (wet) had 31% > 150 μm and 48% < 75 μm, and Tg Gypsum (dry) had 15% > 150 μm, and 69% < 75 μm. All supplemental Ca sources were applied by hand on the soil surface. No incorporation occurred except by natural forces until the lay-by cultivation (flat, not ridged) just prior to fruiting. Materials broadcast were spread uniformly over the whole plot area whereas, those banded were applied to a 61-cm band centered over the rows. The amount of Ca applied per unit area covered was approximately equivalent for comparable treatments whether banded or broadcast (i. e. 605 kg/ha of $CaSO_4$ banded is equivalent in rate per unit area covered to 907 kg/ha broadcast).

Results and Discussion

Weather - Soil Analyses

Precipitation during May through September 1977 was below normal 4 of the 5 months of the peanut growing season. The seasonal deficit in precipitation was 18.4 cm. Precipitation during May and June of 1978 was excessive, nearly normal during July and August, but extremely low in September. The total seasonal rainfall for 1978 was 2 cm above normal. Nevertheless, it is likely that peanut productivity both years was below the normal potential for the sites of the experiments.

General soil analyses of the plot areas prior to initiation of experiments in 1977 and 1978 are given in Table 1. Nutrient contents except Zn were slightly higher in the Kenansville site than in the Rumford site. Greatest differences occurred in contents of available K and Mg among the macro- and secondary nutrients, respectively. Phosphorus contents were very high in both soils.

Productivity

The average yields, seed grades, and crop values obtained from the supplemental Ca treatments applied in 1977 are given in Table 2. A yield increase of approximately 900 kg/ha was required for statistical significance (5% level) between treatments.

Average yields in the Ca-amended plots ranged from 360 to 1200 kg/ha higher than those obtained from the check plots. There were no significant yield differences among the Ca treatments which included 3 sources, 2 rates, 3 methods, and 3 times of Ca application. However, yields from 8 or the 17 Ca treatments were significantly higher than those from the check. The Ca-source was 420-Bulk in 5 of these 8 treatments and Bagged-LP in

Table 1. General soil analyses of test areas prior to establishment of experiments.

Measurements	Contents of available nutrients Kenansville lfs 1977	Rumford lfs 1978
Soil, pH	6.2	5.9
Ca, kg/ha	560	550
Mg, kg/ha	120	70
P, kg/ha	125	110
K, kg/ha	75	60
Mn, ppm	5	4
Zn, ppm	1.5	>6

Table 2. Effect of Ca sources, rates, and methods and dates of application on the productivity of Florigiant peanuts grown on Kenansville lfs in 1977.

	Treatments†							
	Applications		Rate		Sound mature	Extra large	Other	Crop
Sources	Method	Date	$CaSO_4$	Yield	Kernels	Kernels	Kernels	value
			kg/ha	kg/ha	%	%	%	$/ha
Check	-	-	0	2,335b*	40c	13c	8c	682c
Bagged-LP	Brdcst	5/2	907	2,695ab	52b	20b	5b	1,025bc
420-Bulk	Brdcst	5/2	907	2,735ab	56ab	23ab	4ab	1,114ab
Tg Gypsum	Brdcst	5/2	907	3,135ab	58ab	20b	4ab	1,314ab
Bagged-LP	Band	6/2	605	3,275a	60ab	25ab	3a	1,391ab
420-Bulk	Band	6/2	605	3,510a	62a	25ab	3a	1,571a
420-Bulk	Brdcst	6/2	907	3,090ab	60ab	25ab	4ab	1,336ab
Tg Gypsum	Brdcst	6/2	907	2,820ab	58ab	22ab	4ab	1,178ab
Bagged-LP	Band	6/29	605	3,340a	61a	26a	3a	1,465ab
420-Bulk	Band	6/29	605	3,535a	60ab	26a	3a	1,526ab
420-Bulk	Brdcst	6/29	907	3,395a	56ab	23ab	5b	1,363ab
Tg Gypsum	Brdcst	6/29	907	2,955ab	57ab	23ab	4ab	1,223ab
Bagged-LP	Band	6/2	1210	3,285a	62a	23ab	3a	1,472ab
420-Bulk	Band	6/2	1210	3,510a	61a	22ab	3a	1,556a
420-Bulk	Brdcst	6/2	1814	2,980ab	58ab	25ab	4ab	1,262ab
Bagged-LP	Band	6/29	1210	3,065ab	58ab	21ab	4ab	1,284ab
420-Bulk	Band	6/29	1210	3,415a	60ab	25ab	3a	1,334ab
420-Bulk	Brdcst	6/29	1814	3,125ab	58ab	23ab	4ab	1,321ab

*Treatment means followed by all unlike letters are significantly different at the 5% level.

†Bagged-LP = ordinary landplaster, 420-Bulk = U. S. Gypsum 420 Landplaster Bulk, Tg Gypsum = Texasgulf Gypsum (wet); Band = 61 cm wide centered over rows, brdcst = broadcast over entire 91-cm wide rows; Planting = 5/2, early flowering stage = 6/29. Per unit area of soil initially treated, 605 and 1210 kg/ha rates of $CaSO_4$ banded are equivalent to 907 and 1814 kg/ha broadcast, respectively.

Low rates = 605 banded or 907 kg/ha broadcast, high rates = 2 x low rates.

the other 3. Yields from each of these five 420-Bulk treatments averaged somewhat higher than any of the Bagged-LP treatments. The lower Ca rates (605 banded or 907 kg/ha $CaSO_4$ broadcast) were applied in 5 of these 8 treatments and the higher Ca rates (1,210 banded or 1,814 kg/ha $CaSO_4$ broadcast) in the other 3 treatments. The average yields for the six lower Ca treatments, 3 applied 6/2 and 3 on 6/29, were 3,360 kg/ha and the average yields for the six comparable higher-rate treatments were 3,230 kg/ha. Two of the three highest average yields obtained among the 17 Ca treatments were amended at the lower rate. There was a trend toward increased yields from the later dates of application of Bagged-LP and 420-Bulk. The highest yield from any Tg Gypsum treatment was obtained from the application at planting. In those plots, yields averaged approximately 400 kg/ha higher than where the other two sources were applied at the same time. Average yields for the 420-Bulk treatments banded 2 June or 29 June were 340 kg/ha higher than when 420-Bulk was broadcast.

Seed grades were significantly higher in the Ca-amended plots than in the check plots (Table 2). In general, there were only small differences in seed grades among the Ca treatments. However, significantly lower ELK contents were obtained where Bagged-LP or Tg Gypsum were broadcast at planting than where Bagged-LP or 420-Bulk were banded 29 June. In 7 out of 8 cases, the lowest contents (3%) of other kernels (OK) occurred where yields were significantly higher than in check plots. In general, the % OK in fruits from the check plots was twice that where Ca was applied.

Crop value to producers represents the accumulative effect of yield, the principal effectual factor, and grades on the ultimate raw product. The Ca treatments increased average crop value over the check by $343 to $889/ha (Table 2). Only the Bagged-LP treatment applied at planting failed to increase crop value significantly. The highest crop values were obtained where 420-Bulk was banded on 2 June, followed closely by the 29 June band treatment with 420-Bulk at the low rate. Average crop value was not increased by the higher Ca rates.

The average yields, seed grades, and crop values obtained from the supplemental Ca treatments applied in 1978 are given in Table 3. Many of the plots were differentially infected with the disease Sclerotinia blight (14). Significance at the 5% level required yield differences of more than 700 kg/ha.

Yields from the plots where Ca treatments were applied averaged from 265 to 1,115 kg/ha higher than check plot yields. Significantly increased yields were obtained from Bagged-LP broadcast May 25, from both June applications of Bagged-LP banded or Tg Gypsum broadcast, from Tg Gypsum banded in late June, and from all three dates 420-Bulk was broadcast. Over all Ca sources, yields for the late June application averaged 230 kg/ha higher than for the other application dates.

Treatment effects on seed size generally were small (Table 3). Contents of sound mature kernels (SMK) significantly higher than for the check occurred only in plots where 420-Bulk was banded 30 June. Contents of OK lower than for the check occurred only where 420-Bulk was broadcast 30 June.

The crop values per ha of 10 Ca treatments were significantly higher than the check, although all exceeded the check by $200/ha or more (Table 3). Among the Ca treatments, the highest crop value was obtained from plots where Tg Gypsum was banded 30 June, and the lowest when 420-Bulk was banded or Bagged-LP was broadcast 15 June. Also, crop values were among the lowest where Tg Gypsum or Bagged-LP was banded 25 May. Crop values for the 30-June applications averaged approximately $126/ha higher than for the earlier Ca applications.

The 2-years' results indicate, in general, that 420-Bulk and Tg Gypsum were as effective as Bagged-LP for supplemental Ca sources for peanuts. There was a definite trend both years toward higher productivity when the Ca sources were applied in late June versus earlier applications. Comparison of band with broadcast applications over the 2 years can be made only with 420-Bulk.

Table 3. Effects of Ca sources, rates, and methods and dates of application on the productivity of Florigiant peanuts grown on Rumford lfs in 1978.

Treatments[†]					Sound	Extra		
	Applications		Rate		mature	large	Other	Crop
Sources	Method	Date	$CaSO_4$	Yield	kernels	kernels	kernels	value
			-kg/ha-		----------%	----------	----------	$/ha
Check	-	-	0	2,655d*	59bc	22ab	6bcd	1,109d
Bagged-LP	Band	5/25	605	3,025bcd	61ab	25ab	4ab	1,309cd
Bagged-LP	Brdcst	5/25	907	3,440abc	62ab	24ab	5abc	1,519abc
420-Bulk	Band	5/25	605	3,225a-d	62ab	23ab	5a-d	1,408a-d
420-Bulk	Brdcst	5/25	907	3,380abc	62ab	23ab	6a-d	1,485abc
Tg Gypsum D	Band	5/25	605	3,280a-d	55c	21ab	7d	1,302cd
Tg Gypsum W	Brdcst	5/25	907	3,105a-d	61ab	24ab	5ab	1,358a-d
Mean	Both	5/25	Both	3,245b_1	61a_1	23a_1	5a_1	1,397b_1
Bagged-LP	Band	6/15	605	3,515abc	61ab	24ab	5a-d	1,536abc
Bagged-LP	Brdcst	6/15	907	2,950cd	60ab	19b	6a-d	1,257cd
420-Bulk	Band	6/15	605	2,920cd	61ab	22ab	5a-d	1,255cd
420-Bulk	Brdcst	6/15	907	3,405abc	61ab	22ab	6bcd	1,484abc
Tg Gypsum D	Band	6/15	605	3,130a-d	59bc	27a	7cd	1,326bcd
Tg Gypsum W	Brdcst	6/15	907	3,525abc	62ab	23ab	5abc	1,544abc
Mean	Both	6/15	Both	3,240b_1	61a_1	23a_1	6a_1	1,400b_1
Bagged-LP	Band	6/30	605	3,600abc	62ab	24ab	5a-d	1,580abc
Bagged-LP	Brdcst	6/30	907	3,305a-d	61ab	23ab	6a-d	1,423a-d
420-Bulk	Band	6/30	605	2,935cd	64a	24ab	4ab	1,324bcd
420-Bulk	Brdcst	6/30	907	3,770a	62ab	25ab	4a	1,638ab
Tg Gypsum D	Band	6/30	605	3,760a	63ab	24ab	5ab	1,667a
Tg Gypsum W	Brdcst	6/30	907	3,480abc	62ab	22ab	5a-d	1,524abc
Mean	Both	6/30	Both	3,475a_1	62a_1	24a_1	5a_1	1,526a_1
Bagged-LP	Brdcst Band	6/15 6/30	907 302	3,640ab	60ab	23ab	5a-d	1,549abc

*Treatment means followed by all unlike letters are significantly different at the 5% level. Compare multi-treatment means labeled with similar subscripts.

†Bagged-LP = ordinary landplaster, 420-Bulk = U. S. Gypsum Co. 420 Landplaster Bulk, Tg Gypsum W or D = Texasgulf Gypsum in wet condition or dried; Band = 61 cm wide centered over rows, brdcst = broadcast evenly over rows 91 cm; 5/25 = seedling emergence, 6/30 = early flowering stage; Per unit area of soil initially treated, the 605-kg/ha rate of $CaSO_4$ banded is equivalent to 907 kg/ha broadcast.

Productivity was somewhat higher when banded in the 1977 test, but the opposite occurred in 1978. The effects of band vs. broadcast applications of Tg Gypsum on productivity were similar in 1978. The higher rates of Baged-LP or 420-Bulk equivalent to 1,205 kg/ha of $CaSO_4$ banded or 1,814 kg/ha of $CaSO_4$ broadcast did not increase productivity over the 605- or 907-kg/ha rates in 1977. Tg Gypsum was not applied at the higher rates. Productivity was similar whether 1 or 2 applications of Bagged-LP were made in the 1978 test.

Seed Germination - Mineral Contents - Correlations

The percentage germination of peanut seed grown in 1977 and their contents of Ca, Mg, P, K, Mn, Zn, and Cu are given in Table 4. Seed germination was 85% or better for peanuts amended with Ca. Twelve of 17 Ca-treatments produced seed of which more than 90% germinated. Four of the 5 cases which germinated below 90% were 420-Bulk treatments, but these five averaged 87%. The effect of time of Ca application on seed germination was indefinite.

The average contents of Ca and Cu in the seed varied most and the contents of Mg, P, and Mn least among the treatments (Table 4). The highest average Ca content and the lowest P, K, Zn, and Cu contents in the seed were associated with the highest average germination. Seed from the check plots, which had the highest average P and K contents, had the lowest seed germination, However, these contents were not significantly different from several others in each case. The average content of Ca in seed was somewhat higher and the contents of Mg and K somewhat lower for the later Ca applications than when the materials were applied at planting. No trends occurred in the effect of time of Ca application on the average contents of P, Mn, Zn, or Cu in the seed. Seed-Ca contents averaged slightly greater where the higher rates of Bagged-LP or 420-Bulk were applied whereas, no similar trends were noted concerning the other six nutrients.

The percentage germination of peanut seed grown in 1978 and their contents of Ca, Mg, P, K, Mn, Zn, and Cu are given in Table 5. Germinability of these seed generally was rather low. Seed from only three treatments averaged 80% germination or higher. These treatments were Tg Gypsum banded 25 May (85%), and Bagged-LP (84%) or 420-Bulk (80%) banded 30 June. However, the average germination of seed grown under all the band treatments was similar to that where the Ca materials were broadcast. Germination of seed grown in check plots was lowest. The split application of Bagged-LP did not increase germination over single applications. Average germination was significantly higher when the Ca treatments were applied 30 June than when applied 2 June. It was intermediate for the early application.

The average contents of Ca and Cu in the seed in 1978 varied most and contents of Mg and P least among the treatments (Table 5). This occurred in 1977, also. The range in the mineral contents of seed generally was somewhat less in 1978, particularly Ca and Cu. Significantly higher average contents of seed Ca occurred where the latest Ca treatments were applied than for the earliest which, in turn, were higher than seed-Ca levels for the intermediate date of application. Average Zn contents in the seed were higher for the latest Ca application than for the earlier two dates, also. Seed produced where Tg Gypsum was applied were significantly higher in Ca than where 420-Bulk was applied. Seed-Ca contents were intermediate where Bagged-LP was applied.

Average mineral contents of the Florigiant seed (unblanched) were similar both years except the highest Ca contents in 1978 were only about 70% of those in 1977. These contents are similar to or

Table 4. Germinability and contents of 7 nutrients in Florigiant peanut seed grown on Kenansville lfs, 1977.

Treatments†				Seed	Contents of nutrients in seeds						
	Applications		Rate	germi-							
Sources	Method	Date	$CaSO_4$	nation	Ca	Mg	P	K	Mn	Zn	Cu
			kg/ha	%	ppm	%	%	%	ppm	ppm	ppm
Check	-	-	0	76d*	420bcd	0.194abc	0.40a	0.93a	14a	59ab	15.4ab
Bagged-LP	Brdcst	5/2	907	95ab	440bcd	0.197ab	0.36abc	0.87ab	12a	50bc	11.7bcd
420-Bulk	Brdcst	5/2	907	87bc	320de	0.181a-d	0.36abc	0.84ab	13a	46bc	9.0cde
Tg Gypsum	Brdcst	5/2	907	92abc	360cde	0.172cd	0.36abc	0.92a	13a	54abc	9.4cde
Bagged-LP	Band	6/2	605	85c	520ab	0.171cd	0.35bc	0.72b	14a	53abc	10.2cde
420-Bulk	Band	6/2	605	95abc	500ab	0.182a-d	0.36abc	0.83ab	15a	51abc	9.8cde
420-Bulk	Brdcst	6/2	907	93abc	440bcd	0.183a-d	0.36abc	0.89ab	13a	46bc	9.9cde
Tg Gypsum	Brdcst	6/2	907	91abc	450bcd	0.176bcd	0.36abc	0.85ab	14a	48bc	10.1cde
Bagged-LP	Band	6/29	605	96ab	500ab	0.171cd	0.36abc	0.84ab	15a	46bc	9.7cde
420-Bulk	Band	6/29	605	88abc	400bcd	0.185a-d	0.38ab	0.79ab	13a	46bc	7.9de
420-Bulk	Brdcst	6/29	907	89abc	263e	0.168d	0.36abc	0.79ab	14a	63a	8.4de
Tg Gypsum	Brdcst	6/29	907	96ab	450bcd	0.176bcd	0.36abc	0.86ab	13a	50abc	12.2a-d
Bagged-LP	Band	6/2	1210	91abc	533ab	0.175bcd	0.34bc	0.73b	15a	48bc	13.3abc
420-Bulk	Band	6/2	1210	95ab	440bcd	0.181a-d	0.38ab	0.85ab	15a	55abc	16.4a
420-Bulk	Brdcst	6/2	1814	88abc	460bc	0.181a-d	0.38ab	0.96a	12a	49bc	15.0ab
Bagged-LP	Band	6/29	1210	98a*	620a	0.178bcd	0.33c	0.72b	15a	44c	6.6e
420-Bulk	Band	6/29	1210	95ab	473bc	0.204a	0.36abc	0.83ab	15a	49bc	8.7de
420-Bulk	Brdcst	6/29	1814	91abc	470bc	0.170cd	0.34bc	0.81ab	14a	50abc	9.4cde

*Treatment means followed by all unlike letters are significantly different at the 5% level.

† Bagged-LP = ordinary landplaster, 420-Bulk = U. S. Gypsum 420 landplaster Bulk, Tg Gypsum = Texasgulf gypsum (wet); Band = 61 cm wide centered over rows, brdcst = broadcast over entire 91-cm wide rows; Planting = 5/2, early flower stage = 5/29. Per unit area of soil initially treated, 605 & 1210 kg/ha rates of $CaSO_4$ banded = 907 and 1814 broadcast, respectively.

within the ranges, generally, of those reported by Cobb and Johnson (2), Derise et al. (6) and Walker and Hymowitz (18). However, the Ca contents are considerably lower and the K contents slightly higher than those reported by the latter two investigators. Also, seed-Zn contents in Tables 4 and 5 are considerably higher than reported by Walker and Hymowitz (18).

Simple correlation coefficients calculated for the relationships of seed germinability and contents of each mineral in the seed each year are given in Table 6. None of the relationships were close. The Ca contents in the seed both years and K contents in 1978 were about equally and most closely correlated of the seven minerals with percent germination. Seed-K contents were inversely related to germination.

The relatively low germinability of peanut seed grown in 1978 probably was caused by the extremely dry September. Cox et al. (5) and Pallas et al. (13) reported significantly increased germination from irrigation when soil moisture is low. Florigiant was more susceptible to dry soil conditions than small-seeded varieties (13). The beneficial effect of irrigation probably was through increased seed-Ca levels (5).

Cox et al. (5) reported that seed contents below 420 ppm frequently have poor germinability. The average seed-Ca contents for 11 of 20 treatments in 1978 were below 400 ppm (Table 5). There were only three that low in 1977 (Table 4). The negative correlation obtained between seed-K contents and germinability in 1978 and not in 1977, when seed-K levels averaged slightly higher than in 1978, indicates that adverse effects of seed-K on germination may be greater under dry conditions. This K-effect on germination may be interrelated with Ca effects on germination, since Ca-K relationships are of special importance in peanut fruiting. However, variations in seed-Ca and -K contents were not closely correlated (r = 0.21). This effect also could be related to the total nutrient constancy principle in which the contents of a nutrient decreases when another increases and vice versa.

Table 5. Germinability and contents of 7 nutrients in Florigiant peanut seed grown on Rumford lfs, 1978.

Treatments†				Seed germi-	Contents of nutrients in seeds						
	Applications		Rate								
Sources	Method	Date	$CaSO_4$	nation	Ca	Mg	P	K	Mn	Zn	Cu
			kg/ha	%	ppm	%	%	%	ppm	ppm	ppm
Check	-	-	0	56b	309ef	0.203abc	0.360abc	0.80bc	20.0bc	45efg	11.3bc
Bagged-LP	Band	5/25	605	63ab	360d	0.188fg	0.363abc	0.84a	19.2b-e	50bc	9.7def
Bagged-LP	Brdcst	5/25	907	74ab	422ab	0.196c-f	0.345cde	0.71hi	19.2b-e	48cd	10.2cde
420-Bulk	Band	5/25	605	68ab	368cd	0.196c-f	0.335de	0.74fgh	18.8c-f	46ef	10.3cde
420-Bulk	Brdcst	5/25	907	68ab	414abc	0.206ab	0.345cde	0.68j	20.0bc	47de	11.3bc
Tg Gypsum D	Band	5/25	605	85a	412abc	0.187fg	0.370ab	0.71hi	22.0a	46ef	10.3cde
Tg Gypsum W	Brdcst	5/25	907	75ab	329de	0.184gh	0.377a	0.76def	18.0ef	42h	9.0f
Mean	Both	5/25	Both	$72ab_1$	$384b_1$	$0.193a_1$	$0.356a_1$	$0.74d_1$	$19.5a_1$	$46b_1$	$10.1a_1$
Bagged-LP	Band	6/15	605	73ab	330de	0.190fg	0.357a-d	0.76def	18.2def	46def	9.0f
Bagged-LP	Brdcst	6/15	907	75ab	342de	0.201bcd	0.335de	0.74fgh	20.5b	44fg	12.1ab
420-Bulk	Band	6/15	605	63ab	346de	0.194def	0.361abc	0.77cde	17.5f	43gh	10.8cd
420-Bulk	Brdcst	6/15	907	63ab	273f	0.179h	0.345cde	0.74def	19.5b-e	45efg	9.2ef
Tg Gypsum D	Band	6/15	605	67ab	430a	0.211a	0.347b-e	0.72ghi	18.8c-f	46def	10.4cd
Tg Gypsum W	Brdcst	6/15	907	72ab	406abc	0.192efg	0.327e	0.78cd	18.8c-f	46ef	9.8def
Mean	Both	6/15	Both	$69b_1$	$354c_1$	$0.194a_1$	$0.345a_1$	$0.75a_1$	$18.9a_1$	$45b_1$	$10.2a_1$
Bagged-LP	Band	6/30	605	84a	411abc	0.188fg	0.350b-e	0.72ghi	17.5f	42h	8.9f
Bagged-LP	Brdcst	6/30	907	77ab	447a	0.198b-e	0.342cde	0.75def	18.5c-f	51b	12.7a
420-Bulk	Band	6/30	605	80a	422ab	0.196c-f	0.360abc	0.75efg	19.5b-e	51b	10.9cd
420-Bulk	Brdcst	6/30	907	71ab	407abc	0.196c-f	0.330e	0.82b	20.5b	54a	12.5a
Tg Gypsum D	Band	6/30	605	73ab*	432a	0.187fg	0.343cde	0.73f-j	18.5c-f	46def	11.1bc
Tg Gypsum W	Brdcst	6/30	907	77ab	376bcd	0.191efg	0.342cde	0.77cde	17.5f	49c	9.8def
Mean	Both	6/30	Both	$77a_1$	$416a_1$	$0.193a_1$	$0.344a_1$	$0.76a_1$	$18.7a_1$	$49a_1$	$11.0a_1$
Bagged-LP	Brdcst Band	6/15 6/30	907 302	77ab	412abc	0.191efg	0.332e	0.70ij	19.8bcd	46def	9.0f

* Treatment means followed by all unlike letters are significantly different at the 5% level. Compare multi-treatment means labeled with similar subscripts.

Bagged-LP = ordinary landplaster, 420-Bulk = U. S. Gypsum Co. 420 Landplaster Bulk, Tg Gypsum W or D = Texasgulf gypsum in wet or dried condition; Band = 61 cm wide centered over rows, Brdcst = broadcast evenly over rows 91 cm wide; 5/25 = seedling emergence, 6/30 = early flowering stage. Per unit area of soil initially treated, a 605-kg/ha rate of $CaSO_4$ banded is equivalent to 907 kg/ha broadcast.

Table 6. Simple correlation coefficients for relationships between seed germinability and contents of seven minerals in seeds.

Mineral	Correlation coefficients	
	1977	1978
Ca	0.40**	0.45**
Mg	-0.01	-0.03
K	-0.08	-0.43**
P	0.27*	0.15
Mn	0.05	-0.09
Zn	-0.28*	0.01
Cu	-0.18	none

*, **, Siginifcant at 5% and 1% level, respectively.

The Ca-K relationships in seed germinability warrants further attention.

In summary, under average growing conditions 420-Bulk, Tg Gypsum, or Bagged-LP should be equally effective sources of supplemental Ca for peanuts. Productivity and seed germinability was somewhat higher when the Ca sources were applied at early flowering stage than when applied earlier. Double rates of Bagged-LP or 420-Bulk did not increase productivity or seed germinability more than the low rates. A single application of Bagged-LP was as effective as split applications in 1978.

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