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# Soil Or Foliar Applied Nutrient Effects On Mineral Concentrations And Germinability Of Peanut Seed[1]

D. L. Hallock[2]


### ABSTRACT

The mineral composition of peanut (*Arachis hypogaea* L.) seed is important to seed germinability, human dietary quality, and may indicate nutrients limiting peanut productivity. Low germinability of peanut seed is frequently a problem for seed producers. Little is known about nutrient effects on seed germination except for Ca. Experiments were conducted on two Aquic Hapludults, one in Southampton Co. and the other in Suffolk, Va. The effects of lime, N, P, K, Ca, Mg, Mn, Zn, Cu, B, S, or Fe applied to the soil and/or foliage on the elemental composition and germinability of peanut seed were studied.

Average germination varied from 39 to 82% and was highest where 1,120 or 3,360 kg/ha of landplaster (LP) was applied alone. Germination was decreased by application of KCl or $K_2SO_4$ at 1,120 kg/ha, or urea or $NH_4NO_3$ each at 224 kg/ha of N. Percentage germination was correlated positively with seed Ca and negatively with seed K concentrations. Also, a low but significant negative correlation was obtained between Fe or Cu and seed germinability.

All treatments which contained considerable Ca increased the Ca concentrations in seed, except lime at 2,240 kg/ha. Concentrations of K in the seed were increased by the K treatments only when LP was not applied. Treatments which included foliar-applied Zn or both Zn and Mn decreased seed K or seed Mg levels, respectively. None of the treatments decreased Fe, Cu, P, Mn, or Zn concentrations in seed.

The concentrations of the nutrients in the seed varied relative to the method of application. Fertilization practices which increase Ca uptake by the seed relative to K should enhance peanut seed germinability.


Key Words: *Arachis hypogaea* L., Groundnuts, Macronutrients, Micronutrients.

The mineral composition of peanut (*Arachis hypogaea* L.) seed is important to seed germinability (4, 11), human dietary quality, and may indicate nutrients limiting peanut productivity. Low germinability of peanut seed is frequently a problem for seed producers. Little is known about nutrient effects on seed germination except for Ca. Peanut fruit and roots both absorb nutrients from the soil (1, 2, 3, 8).

Derise, et al. (5) analyzed seed samples of field-grown 'Florigiant' peanuts obtained from the Tidewater Research and Continuing Education Center, Suffolk, Va. Average concentrations of Ca, Mg, P, K, Fe, Cu, Zn, and Mn were 878, 1,652, 4,703, 6,266, 15.8, 12.6, 60.9 and 20.1 ppm, respectively. These levels were similar to those reported by Sullivan, et al. (11) for NC 5 and by Hallock and Allison (7) for Florigiant, except that the Ca, P, Zn, and Cu levels were a little lower and K levels a little higher in the latter studies. All of the above results, except that for Fe, which is lower, are within the ranges for nutrient concentrations in peanut seed of several varieties analyzed by Walker and Hymowitz (12).

Recently, the relationship of the Ca concentration in peanut seed to germination has been of special interest. Harris and Brolmann (9) reported that 72% of the peanuts which contained 0.03% Ca germinated, whereas 100% of those that contained 0.08% germinated. Cox, et al. (4) found that germinability decreased rapidly where seed Ca concentrations decreased below 420 ppm. Dry weather during peanut fruit development may affect germination adversely (4, 10). Cox, et al. (4) noted that a major portion of the effect of irrigation on seed germinability probably was due to increased seed Ca levels. Hallock and Allison (7) obtained significant positive correlation in 1977 and 1978 between peanut seed Ca concentrations and germination. In 1978, when seed matured in dry soil, germinability was negatively related to seed K levels. Sullivan, et al. (11) reported significant increases in seed germination and Ca levels from applied gypsum.

This investigation was conducted in 1978 to study the effects of applied nutrients on the mineral concentrations and germinability of Virginia market type peanut seed. These nutrients were applied alone and/or in various combinations to the soil or foliage. The results are reported in this paper, including the correlation found between nutrient concentrations and percentage germination of the seed.

## Materials and Methods

The experiments were conducted in 1978 at two locations on private farms in Virginia. One site located in Southampton County was Altavista lfs (Aquic Hapludult, coarse-loamy, mixed, thermic) and the other located in Suffolk was Slagle fsl (Aquic Hapludult, fine-loamy, siliceous, thermic). The general fertility levels (6) given in Table 1 for these soils prior to treatment represent double acid-extractable P, K, Ca, Mg, and Mn, and 0.1M EDTA + 1.0M $(NH_4)_2CO_3$-extractable Zn. Soil pH was determined by the 1:1 soil-water method. A 2-year rotation of

[1]Contribution of Agronomy Department, Virginia Polytechnic Institute and State University, Blacksburg, Va. 24061. Research supported in part by the Virginia Agricultural Foundation.

[2]Associate Professor of Agronomy, Research Division, Tidewater Research and Continuing Education Center, Va. Polytech. Instit. & S. U., Holland Station, Suffolk, Va. 23437.

**Table 1. Surface soil analyses prior to experiments.**

| Chemical determination† | Altavista lfs | Slagle fsl |
|---|---|---|
| Soil pH | 5.4 | 5.8 |
| P, kg/ha | 70 | 125 |
| K, kg/ha | 155 | 140 |
| Ca, kg/ha | 325 | 475 |
| Mg, kg/ha | 30 | 40 |
| Mn, ppm | 1.8 | 4.2 |
| Zn, ppm | 1.8 | 2.3 |

†Samples analyzed in State Soils Laboratory, Va. Polytech. Inst. and S. U.

corn and peanuts normally had been followed at both sites. No nutrients were applied except in the treatments.

The plots were four rows 91 cm wide and 5.9 m long with treatments arranged in a randomized complete block design with four replications. Pesticides[3] were applied according to Virginia recommendations (13). Applications of Vernolate, Benefin, Alachlor, Dinitro, Butonate, Aldicarb, and Methomyl were applied at both sites in addition to Diphenamid and Chlorothalanil at the Altavista location and Benomyl at the Slagle location. The nutrient treatments applied in both experiments are listed in Table 2. Rototilled treatments were incorporated into the 0- to 5-cm layer. The spray treatments were applied on the foliage with a $CO_2$ pressure-regulated backpack sprayer delivering 140 liters/ha at 2.8 kg/cm². Florigiant and Va. 72R peanuts were planted at the Slagle and Altavista sites, respectively, about 15 May, dug about 10 October and combined after curing several days in the windrow. The partially dried fruit were further dried artificially to ca 9% moisture contents and seed samples obtained for chemical and germination determinations.

Dry (70°C) 1-g samples of finely ground seed were ashed at 450°C for 2.5 hours and the nutrient constituents of the ash dissolved in 25 ml of 0.5 N HCl. Potassium was determined by flame emission and Ca, Mg, Mn, Zn, Cu, and Fe by atomic absorption spectrophotometry. Phosphorus was determined by an ammonium vanadate procedure. Estimation of seed germinability was made by placing 50 sound mature seed from each of the same samples analyzed for mineral content in a Seedboro Model 300 Germinator set at 27°C. The seeds were treated with Dicloran-Captan to preclude fungal infection and with Ethephon to break possible dormancy. Seed which had not produced hypocotyls longer than 1 cm after 10 days in the germinator were considered non-viable. Duplicate samples of seed were analyzed for chemical composition and germinability.

# Results and Discussion

Weather conditions generally were favorable for peanut production at both locations. Temperatures were near normal most of the growing season. Total precipitation for the growing season was above normal, but was quite deficient in September as peanut fruit matured.

## Mineral Concentrations

The average nutrient concentrations and percentage germination of seed from each treatment are given in Table 3.

[3]Use of a commercial product does not imply preferential endorsement by Va. Polytech. Instit. and S. U. over similar products from other manufacturers.

**Table 2. Nutrient treatments applied on field-grown peanuts in 1978.**

| Materials† | Rate kg/ha | How applied | Dates applied |
|---|---|---|---|
| Landplaster (LP-3x) | 3,360 | Banded (61 cm) | 6/20 |
| Landplaster (LP-x) | 1,120 | Banded (61 cm) | 6/20 |
| $MgSO_4$ + | 1,120 | Sidedressed&rototilled | 6/20 |
| Landplaster (LP) | 1,120 | Banded (61 cm) | 6/20 |
| KCl (50%) + | 1,120 | Sidedressed&rototilled | 6/20 |
| Landplaster (LP) | 1,120 | Banded (61 cm) | 6/20 |
| Superphosphate (44%) | 1,120 | Sidedressed&rototilled | 6/20 |
| $K_2SO_4$ + | 1,120 | Sidedressed&rototilled | 6/20 |
| Landplaster (LP) | 1,120 | Banded (61 cm) | 6/20 |
| Lime, pulverized dolomite | 2,240 | Broadcast&rototilled | 5/18 |
| $MnSO_4 \cdot 2H_2O$ | 33.6-Mn | Banded (61 cm) | 6/20 |
| $ZnSO_4$ | 22.4-Zn | Banded (61 cm) | 6/20 |
| Solubor | 0.56-B | Spray | 6/18 |
| Check - untreated | -- | -- | -- |
| Nutra-Phos 3-15 | 30.24 | 4-7.56 kg/ha sprays | 6/28,7/18,8/9,9/6 |
| $ZnSO_4$ | 4.48-Zn | 4-1.12 kg/ha sprays | 6/28,7/18,8/9,9/6 |
| Manzate 200 | 8.96 ai | 4-2.24 kg/ha sprays | 7/18,8/1,8/18,9/6 |
| $CuSO_4 \cdot 5H_2O$ | 4.48-Cu | 4-1.12 kg/ha sprays | 6/28,7/18,8/9,9/6 |
| Flowable S | 20.2-S | 4-5.05 kg/ha sprays | 6/28,7/18,8/9,9/6 |
| $CuSO_4 \cdot 5H_2O$ | 11.2-Cu | Banded (61 cm) | 6/20 |
| $FeSO_4 \cdot 7H_2O$ | 4.48-Fe | 4-1.12 kg/ha sprays | 6/28,7/18,8/9,9/6 |
| Urea + | 224-N | Sidedressed&rototilled | 6/20 |
| Nitrapyrin (NS) | 0.56 | Sidedressed&rototilled | 6/20 |
| $MnSO_4 \cdot 2H_2O$ | 4.48-Mn | 4-1.12 kg/ha sprays | 6/28,7/18,8/9,9/6 |
| Nutra-Phos ZMC | 44.8 | 4-11.2 kg/ha sprays | 6/28,7/18,8/9,9/6 |
| Urea | 224-N | Sidedressed&rototilled | 6/20 |
| KCl (50%) | 1,120 | Sidedressed&rototilled | 6/20 |
| $NH_4NO_3$ | 224-N | Sidedressed&rototilled | 6/20 |
| $K_2SO_4$ | 1,120 | Sidedressed&rototilled | 6/20 |

†Landplaster was fine anhydrite. Nutra-Phos ZMC contained 4% $P_2O_5$, 9% Ca 8% S, 6% Cu, 10% Mn, 10% Zn; Nutra-Phos 3-15 contained 15% $P_2O_5$, 15% Mn, 15% Zn; Manzate 200 contained 16% Mn, 2% Zn; nitrapyrin source = N-Serve.

All treatments except lime, which contained considerable Ca, increased the Ca concentration in seed. This lack of response to lime seems somewhat anomalous especially since that material was quite finely ground (75% < 150$\mu$m). Even the lower rate of LP generally supplied more Ca available for absorption by seed than the lime treatment which contained considerably more Ca. The Ca concentration in seed grown in plots which received the other materials without LP was similar generaly to that in check plot seed.

None of the treatments significantly increased the K concentration in the seed, but seed from the K treatments (no LP) were highest in K. However, nine treatments significantly decreased the seed K concentration below that in seed from check plots. Six of these treatments were those which contained considerable Ca, which probably suppressed K absorption by the seed. The other three treatments were Nutra-Phos ZMC (ZMC), $ZnSO_4$, and Manzate 200 sprayed on foliage. All of these materials contain Zn, although the Manzate 200 contains very little. ZMC and Manzate 200 contain Mn, and ZMC contains Cu. None of the other Mn or Cu amendments, however, affected seed K significantly. Another Zn containing material, Nutra-Phos 3-15 (3-15), also reduced K levels although not quite significantly. This apparent depressive effect of Zn on seed K levels occurred at both

**Table 3. Fertility treatment effects on average nutrient concentrations and germination of seed grown on two soil types, 1978. Also, linear correlation coefficients (r-values) are given for the relationship between the concentration of each nutrient and seed germinability.**

| Treatments† | Nutrient concentrations in seed | | | | | | | | Germination |
|---|---|---|---|---|---|---|---|---|---|
| | Ca | K | Fe | Cu | P | Mg | Mn | Zn | |
| | ppm | | | | | | | | % |
| LP-3x | 631a* | 7,032gh | 25.1b | 11.2cde | 3,650def | 2,021ab | 17.2b-e | 39.4c-g | 82a |
| LP-x | 605ab | 7,012h | 28.4b | 11.5cde | 3,619ef | 1,939bc | 17.8bcd | 40.1c-f | 80ab |
| $MgSO_4$ + LP | 535abc | 7,044gh | 22.3b | 13.0bcd | 3,694b-f | 1,899bc | 17.3b-e | 41.9b-e | 78abc |
| KCl + LP | 559ab | 7,237fgh | 26.1b | 11.9cde | 3,681c-f | 1,990bc | 16.8b-e | 41.0b-f | 72a-d |
| Superphosphate | 519bcd | 7,562c-h | 27.3b | 9.9e | 3,762a-f | 1,971bc | 17.5bcd | 36.9efg | 72a-d |
| $K_2SO_4$ + LP | 515bcd | 7,213fgh | 23.2b | 11.7cde | 3,706b-f | 2,165ab | 16.0b-f | 38.4d-g | 69a-e |
| Lime | 443cde | 7,344fgh | 30.2b | 11.5cde | 3,725b-f | 2,336a | 14.4f | 34.4g | 68a-e |
| $MnSO_4$ band | 394e | 7,769a-f | 26.2b | 12.6bcd | 3,732b-f | 2,100ab | 20.6a | 37.8efg | 63c-f |
| $ZnSO_4$ band | 392e | 7,725a-f | 24.7b | 11.5cde | 3,806a-f | 2,130ab | 15.9b-f | 49.6a | 62c-f |
| Solubor | 448cde | 7,606b-h | 29.4b | 11.0de | 3,737b-f | 1,910bc | 17.1b-e | 38.6d-g | 62c-f |
| Check | 406e | 7,981a-e | 27.5b | 10.9de | 3,706b-f | 2,326a | 15.4def | 38.6d-g | 62c-f |
| Nutra-Phos 3-15 | 399e | 7,425e-h | 26.6b | 12.9bcd | 3,594f | 1,865c | 17.1b-e | 44.3bc | 60def |
| $ZnSO_4$ spray | 405e | 7,231fgh | 29.2b | 11.5cde | 3,800a-f | 1,943bc | 16.6b-e | 43.8bcd | 60def |
| Manzate 200 | 435cde | 7,375fgh | 24.2b | 12.1cde | 3,750a-f | 1,870c | 17.2b-e | 36.6efg | 58d-g |
| $CuSO_4$ | 443cde | 7,444d-h | 26.8b | 19.3a | 3,718b-f | 2,111ab | 15.6c-f | 34.4g | 57d-g |
| Flowable S | 412e | 7,812a-f | 27.1b | 13.0bcd | 3,612f | 2,329a | 15.4def | 36.0fg | 56d-g |
| $CuSO_4$ band | 393e | 7,782a-f | 25.1b | 11.7cde | 3,775a-f | 1,905bc | 15.3def | 36.9efg | 56d-g |
| $FeSO_4$ spray | 385e | 7,631b-g | 26.7b | 11.7cde | 3,731b-f | 1,921bc | 15.2ef | 35.6fg | 56d-g |
| Urea + NS | 364e | 8,150abc | 29.2b | 12.5bcd | 3,931ab | 1,949bc | 18.1b | 40.5b-f | 55e-h |
| $MnSO_4$ spray | 392e | 7,732a-f | 24.8b | 11.9cde | 3,700b-f | 2,086ab | 17.0b-e | 37.3efg | 54e-h |
| ZMC | 355e | 7,212fgh | 21.4b | 13.6bc | 3,606f | 1,835c | 17.2b-e | 45.7ab | 50fgh |
| Urea | 402e | 8,038a-d | 31.2b | 13.3bcd | 3,856a-e | 2,118ab | 17.3b-e | 39.1c-g | 42gh |
| KCl | 423de | 8,175ab | 57.1a | 14.6b | 3,862a-d | 2,101ab | 16.1b-f | 42.2b-e | 42gh |
| $NH_4NO_3$ | 396e | 8,150abc | 28.6b | 12.7bcd | 3,900abc | 1,908bc | 17.5bcd | 40.1c-f | 40h |
| $K_2SO_4$ | 393e | 8,269a | 69.7a | 12.8bcd | 3,968a | 1,892bc | 16.1b-f | 40.6b-f | 39h |
| r-values | 0.620** | -0.456** | -0.275** | -0.205* | -0.167 | 0.140 | -0.023 | 0.006 | -- |

†Complete treatment listing in Table 2. NS = N-Serve; LP = Landplaster.

*,**Significant at the 5% and 1% levels, respectively. Treatment means followed by all unlike letters are significantly different at the 5% level.

sites. Increased yields from foliar spray treatments containing Zn occurred at one site but not the other. The Zn to K ratio seems too low to readily affect nutrient concentrations via dilution effects, and suggests that other factors probably are involved. However, the Zn soil treatment did not reduce K concentrations in seed.

None of the treatments decreased Fe concentrations in seed (Table 3). Only the two K treatments without LP increased the average concentration of Fe in the peanut seed. This effect was appreciable only in seed grown in the Altavista soil. Since the foliar application of $FeSO_4$ did not increase seed Fe levels, the fruit apparently absorbed considerable Fe directly from the soil. These K salts may have increased soil acidity long enough to liberate additional Fe in the Altavista soil. However, the N treatments probably increased soil acidity also, but they had no appreciable effect on Fe absorption by the fruit. Fruit yields were reduced considerably more by the K treatments (no LP) in the Altavista than in the Slagle soil.

Concentrations of Cu in the seed, were not decreased by any treatment. However, the $CuSO_4$ sprays nearly doubled Cu levels over that in check plot seed. The ZMC sprays, which contain Cu, increased Cu concentrations in the seed to a much lesser degree, but the ZMC contained considerable Zn and Mn which normally would compete with Cu. Much of the Cu in seed probably was translocated from the vegetation since application of 11.2 kg/ha of Cu as $CuSO_4$ did not affect seed Cu levels appreciably. Average seed Cu concentrations were increased significantly by KCl (no LP). Reduced yields from applied K without LP may have affected Cu levels in seed as noted for Fe, although Cu levels in seed grown in either soil were increased.

Phosphorus concentrations in seed varied relatively little among the treatments. None of the treatments reduced seed P levels. Only the $K_2SO_4$ treatment without LP significantly increased seed P levels. The detrimental effect of this treatment on yields probably caused less dilution of P available for translocation to fruit.

Although none had any large effects, many treatments significantly decreased average Mg concentrations in the seed (Table 3). These effects were more pronounced in seed grown in Altavista soil which contained less Mg than the Slagle soil. The treatments which decreased Mg levels in seed most were ZMC, Manzate 200, and 3-15. The nutrients applied in each of these treatments, and some of the other treatments which reduced seed Mg concentrations, were Zn and Mn. Since the soil or foliar $MnSO_4$ treatments did not affect Mg levels in seed appreciably, foliar applied Zn appeared related to decreased seed Mg levels. However, dilution of Mg because of increased fruit production may have occurred.

Manganese applied to the soil increased average Mn concentrations in seed most, followed by the urea treatment which included nitrapyrin (NS). The probable delay in nitrification of urea by the NS may have resulted in the exchange of some absorbed Mn by the ammonium ions, thus increasing Mn uptake by the peanut fruit somewhat. No treatment decreased seed Mn levels.

Zinc concentration in the seed (Table 3) was increased most by the $ZnSO_4$ soil treatment. Also, the Zn spray treatments except Manzate 200 increased seed Zn levels. The other treatments did not affect seed Zn concentration significantly.

The nutrient concentrations in the seed generally are within the ranges reported elsewhere (5, 7, 12). Certain differences, however, should be noted. Seed Ca concentrations averaged somewhat lower and Mg slightly higher than reported by these investigators. Derise, et al. (5) found higher P and Zn and Walker and Hymowitz (12) lower Zn levels than reported in Table 3. Average Fe concentrations reported by Derise, et al. (5) were lower than recorded in Table 3.

**Germinability**

Only the two landplaster treatments, LP-3x and LP-x, significantly increased the average percentage of seed germination significantly (Table 3). The K (no LP) and N treatments, except urea + NS, were the only materials which decreased seed germinability significantly. The linear correlation coefficients obtained for the relationship between the average germination and the concentration of each nutrient determined in the seed are given in Table 3. Among the eight nutrients considered, seed Ca concentration was correlated positively and most closely with percentage germination. The correlation coefficient indicated that variability in seed Ca could explain 38% of the variability in germination. This relationship was somewhat higher than that obtained in 1977 and 1978 on Kenansville and Rumford lfs, respectively (7). The relationship of seed K concentrations with germinability also was highly significant. It was negative and differences in the K levels could explain 21% of the variability in germination. A similar (r = -0.43) relationship was reported by Hallock and Allison for a Rumford soil (7). In the present study, a low but significant negative correlation was obtained between the Fe or Cu concentration in the seed and germinability.

These results indicate that among the nutrients studied, variations in the Ca and K concentrations in the field-grown peanut seed were most closely related to the variations found in germinability. Additional evidence was obtained that the concentrations of the other nutrients in the seed are readily influenced by soil and/or foliar applied amendments. The concentrations of these nutrients in the seed varied relative to the method of application. Among the nutrients applied, fertilization practices which increased Ca uptake by the seed relative to

K, particularly, should enhance peanut seed germinability.


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