Foliar Fertilization of Virginia-Type Peanut with MnEDTA—Crop Grade, Pod Yield, and Value[1]

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ABSTRACT

Manganese is an essential plant micronutrient and has many functions in the plant. Deficient levels of manganese in the plant result in reduced crop yields. This study was conducted to determine the effects of foliar application of manganese salt of ethylenediamine tetra-acetate (MnEDTA) and the timing of application of the MnEDTA to the peanut (*Arachis hypogaea* L.) plant on crop grade, pod yield, and value. Field trials were conducted in Virginia during 1990 and 1991 to determine the optimum amounts of MnEDTA needed for production of the virginia-type peanut. The predominant soil type was Yemassee fine sandy loam (fine-loamy, siliceous, thermic Aeric Achroquults). Manganese treatments enhanced fancy pod development and increased the percentage of extra large kernels for NC-V 11 and NC 7. Other grade factors were not influenced. Average pod yield increases over the control were 25 and 109% for NC-V 11 in two tests during 1990. In 1991 average pod yield increase for NC-V 11 and NC 7 above the control were 65 and 103%, respectively. Crop values paralleled the pod yield data in comparison to the control and standard treatments. MnEDTA treatments were comparable to the standard treatments especially at the higher rates. Amounts of Mn, as MnEDTA, needed for foliar application to peanut were 0.3 to 0.6 kg ha^{-1} per application. Results show that early initial application was needed (4 to 6 wk after planting) with at least three applications applied at 2-wk intervals.

Key Words: Micronutrients, manganese deficiency, timing of application, crop production.

Manganese is an important micronutrient and has many functions in the plant. Its most well-known function is its involvement in photosynthetic O_2 evolution (Hill Reaction) in chloroplasts (Römheld and Marschner, 1991). Deficient levels of manganese in the plant result in lower yields (Hallock, 1979; Mascagni and Cox, 1984, 1985). At least 25 states have reported manganese deficiencies in crops (Berger, 1962). Virginia and North Carolina reported deficiencies for peanut and soybean (*Glycine max* L.). Virginia also reported deficiency for corn (*Zea mays* L.).

Foliar application of manganese to peanut in Virginia is recommended when soil tests for manganese are 3.0 ppm or below (Swann, 1992). Recent unpublished research has indicated that the 3.0 ppm threshold level may be too low. Soil pH also is an important factor to consider when evaluating soil manganese for crop production (Donohue and Hawkins, 1979).

Most research has shown that high rates of soil-applied manganese were needed for correction of manganese deficiency (Rumpel *et al.*, 1967; Alley *et al.*, 1978; Shuman *et al.*, 1979; Mascagni and Cox, 1985). Banding was more efficient than broadcast applications (Randall *et al.*, 1975; Mascagni and Cox, 1985) provided that there was adequate moisture available for normal plant growth and development (Alley *et al.*, 1978). Water-soluble forms of manganese, such as $MnSO_4$, were superior to the insoluble sources such as MnO (Rumpel *et al.*, 1967). Soil applications of manganese ethylenediaminetetraacetic acid were not successful in correction of manganese deficiency in soybean (Randall *et al.*, 1975).

Foliar applications of manganese to corn and soybean have proven successful for correction of manganese deficiency (Randall *et al.*, 1975; Alley *et al.* 1978; Mascagni and Cox 1984, 1985). Timing of application and number of applications were reported to be important to correct the deficiency. Mascagni and Cox (1985) reported early initiation of foliar spraying at 4 wk after planting was superior to later initiation of spraying. Yields of soybeans were 30% lower when foliar spraying was initiated at 10 wk after planting than when spraying was initiated at 4 wk after planting. Multiple applications have been reported to be superior to single applications (Randall *et al.*, 1975; Gettier *et al.*, 1985).

Mederski and Hoff (1958) reported that a relatively short time (15 min) is required for soybean leaves to accumulate high concentrations of manganese from manganese sprays. Manganese absorbed by the leaves increased with an increase in manganese concentration in the applied solution, with an increase in plant tissue, and with length of time the manganese remained in solution on the leaf surface.

Little research has been reported on the manganese requirement of peanut. Hallock (1979) reported an average of 50% pod yield increase for peanut when foliar-applied manganese sources were applied to peanut during a year with adequate rainfall for good peanut production. The manganese was applied in three to four applications at 0.15 to 1.12 kg ha^{-1} per application. Soil-applied manganese sources increased yields by an average of 30% when 3.4 to 22.4 kg ha^{-1} of manganese was used, either banded in the row or broadcast. In a year with lower rainfall, foliar-applied manganese increased yields by an average of 39%, whereas soil-applied manganese increased yields by an average of 30%. Parker and Walker (1986) reported that application of 10, 20, and 40 kg ha^{-1} $MnSO_4$ broadcast and incorporated into the top

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7.62 cm of 6.7 to 6.9 pH soil resulted in a 58, 68, and 87% yield increase, respectively. No significant yield response to soil-applied manganese at soil pH levels of 5.2 or 6.0 was observed. For foliar application, Hallock (1979) reported the first spray should be applied 4 to 5 wk after planting and repeated each 2 to 4 wk until late August. Multiple applications were critical.

For commercial peanut production in the Virginia-North Carolina region, tank mixes of manganese and boron are common for foliar application. The recommended source of boron, sodium borate (disodium octaborate tetrahydrate, $Na_2B_8O_{13}{\cdot}4H_2O$), raises the solution pH when added to the tank-mix. Powell (1993) reported spray-tank-mix pH was critical in keeping manganese inorganic salts in solution. For the pH levels studied (pH 4.6 to 8.4), 20 to 25% of the inorganic salts of manganese ($MnSO_4{\cdot}H_2O$, $MnCl_2$, $Mn(NO_3)_2{\cdot}4H_2O$) precipitated from solution while 100% of the chelated manganese salt of ethylene diamine tetra-acetate (EDTA) remained in solution.

The objective of this study was to determine the responses of peanut grade, pod yield, and crop value to the foliar application of manganese salt of ethylenediamine tetra-acetate (MnEDTA) and to timing of application. The study was conducted over two growing seasons with two virginia-type peanut cultivars.

Materials and Methods

Field Test. Field tests were conducted in 1990 and 1991 on the Yemassee fine sandy loam (fine-loamy, siliceous, thermic Aeric Achraquults) as the predominant soil type. The study areas, located on a commercial farm, included small amounts of Myatt fine sandy loam (fine-loamy, siliceous, thermic Aeric Achraquults), Weston sandy loam (coarse-loamy, siliceous thermic Typic Achraquults), and Dragston loamy sand (coarse-loamy, mixed, thermic Aeric Achraquults). The previous crops were soybean and corn in 1990 and 1991, respectively. Peanuts were produced using standard recommendations (Swann, 1992), and all plots were treated similarly except for the manganese treatments. Peanuts were planted during the second week of May and harvested in early October. Treatments were arranged in a randomized complete block design with four replications. Plots were four rows wide and 12.2 m long with a row spacing of 0.9 m. Manganese was applied through a pressurized sprayer using 140 L ha^{-1} of water. Distilled water was used for all spray mixtures. The spray solution was applied in a 0.30-m band over the foliage with one spray nozzle row^{-1}, in a 0.45-m band over the foliage with two spray nozzles row^{-1}, or in a 0.91-m band over the foliage with two spray nozzles row^{-1} (broadcast application). The sources of manganese used were TECMANGAM™ and LIBREL™ MnEDTA. The TECMANGAM™ contained 28.5% Mn with 99% water solubility. The LIBREL™ MnEDTA contained 13% water-soluble Mn. Peanut cultivars used in the study were NC-V 11 in 1990 and 1991 and NC 7 in 1991.

Treatments in 1990. Manganese treatments for 1990 were applied in two tests. One test consisted of three amounts of MnEDTA (0.56, 1.12, and 1.68 kg ha^{-1}, broadcast rate) applied to the crop two times with approximately a 2-wk interval between each application. Treatments were applied on 2 and 17 July. A second test consisted of three amounts of MnEDTA (1.12, 2.24, and 4.48 kg ha^{-1}, broadcast rate) applied to the crop three times with approximately a 2-wk interval between each application. Two sets of treatments were applied, with the first set on 15 June, 2 July, and 17 July, and the second set on 2 July, 7 July, and 1 Aug.

Treatments in 1991. Manganese treatments for 1991 consisted of five rates of MnEDTA (0.56, 1.12, 1.67, 2.24, and 4.48 kg ha^{-1}, broadcast rate) applied to the crop three times with a 2-wk interval between each application. One set of treatments was applied on 12 June, 26 June, and 10 July and a second 2 wk later on 26 June, 10 July, and 24 July.

Standard Treatment. The standard recommended treatment each year consisted of an application of TECMANGAM™ applied at the rate of 1.12 kg ha^{-1} (broadcast rate) of Mn per application on 2 July, 17 July, and 1 Aug. in 1990 and 26 June, 10 July, and 24 July in 1991 (Swann, 1992). An untreated control was included in each test for both years of the study.

Weather Data. Total heat units were determined for each season from the date of planting until the date of harvest (digging of peanut). Daily heat units were calculated by:

$$H = [(T_{max} + T_{min})/2] - 13.3 \qquad \text{[Eq. 1]}$$

where:

H = daily heat units,

T_{max} = maximum daily temperature (C), and

T_{min} = minimum daily temperature (C).

When the maximum temperature was above 35 C, T_{max} was set to 35 C. When the minimum temperature was below 13.3 C, T_{min} was set to 13.3 C. Seasonal heat unit accumulations are a summation of the daily heat unit calculations. Temperature and precipitation data used in this study are those reported by Powell and Gray (1991, 1992).

Harvesting and Grading. The center two rows of each plot were utilized for all observations and measurements. Peanut pods were harvested mechanically and artificially dried to approximately 9% moisture following partial drying in the windrow. Pod and seed grades were determined from 454 g of unshelled samples. Standard grading procedures of the USDA Federal Crop Inspection Service were followed (USDA, 1981).

Soil samples obtained from each plot prior to planting in 1990 and approximately 4 wk after planting in 1991 were air-dried and passed through a 1.68-mm sieve. Soil pH was determined using distilled water and an Ion Sensitive Field Effect Transistor pH meter (McLean, 1982). Extractable Mn was determined by the double acid (0.05N HCl + 0.025N H_2SO_4) procedure described by Gambrell and Patrick (1982). Charcoal was not used in the extraction and Mn concentration in the solution phase was determined by atomic absorption spectrometry using a Perkin-Elmer 2380 atomic absorption spectrophotometer.

Data Analysis. Pod yield, crop value, and grade data were analyzed by analyses of variance and significant differences between treatment means were determined by Duncan's new multiple range test (Steel and Torrie, 1960). Comparisons of each treatment mean with a control or standard was made by the Dunnett's procedure (two-sided comparison) described by Lentner and Bishop (1986). Grade data reported are fancy pods (FP), extra large kernels (ELK), sound mature kernels (SMK), and total kernels (TK).

Results

Growing Season. Recorded rainfall for each growing season is reported in Table 1. The 1990 growing season had below average rainfall, with lower-than-normal amounts received in June, July, and September. Rainfall for 1991 was near normal, especially during the critical months of July, August, and September. Heat unit accumulation for the growing season was higher in 1991 than in 1990 (Table 2). Climatic conditions in 1991 were more suitable for optimum peanut production.

Table 1. Monthly rainfall recorded during the 1990 and 1991 growing seasons as reported by the Holland 1E National Weather Observing Station, Suffolk, VA.

Year	Month						Season total
	May[a]	Jun.	Jul.	Aug.	Sep.	Oct.	
	mm						mm
1990	96	50	76	193	27	7	449
1991	27	39	202	116	129	—	513
Normal[b]	96	109	148	149	106	86	694

[a]Rainfall reported from date of planting through date of harvest.

[b]Normal rainfall reported for complete month (based on 59 yr of weather records).

Table 2. Planting and harvest dates, and total heat unit accumulation during the 1990 and 1991 growing seasons.

Year	Date		Heat unit accumulation
	Planted	Harvested	
			G
1990	16 May	9 Oct.	1404[a]
1991	10 May	1 Oct.	1525

[a]Heat unit accumulation from date of planting until date of harvest.

Soil pH and Mn. Soil pH level averaged 5.9 with an extractable Mn amount of 1.8 mg kg^{-1} for the rate test in 1990. The experimental area for the rate × timing test had a soil pH of 5.6 and extractable Mn of 1.3 mg kg^{-1}. For the 1991 rate × timing tests the soil pH within the experimental area was 5.6 with extractable Mn of 3.8 and 4.8 mg kg^{-1} for NC-V 11 and NC 7, respectively.

Rate Test in 1990. Grade, pod yield, and crop value data for the rate tests in 1990 are reported in Table 3. No differences in pod yield and crop value were detected among the three rates of MnEDTA. Yield and value of all three MnEDTA treatments were greater than the control but were not different from the standard. The 1.12 MnEDTA treatment contained a higher percentage of FP than the other MnEDTA treatments and control. The SMK of the 0.56 MnEDTA treatment was higher than the standard, but did not differ from the control.

Rate × Timing Test in 1990. The grade, pod yield, and crop value data for the rate × timing test for 1990 are presented in Table 4. There were no significant differences in grade, pod yield, and crop value observed among the MnEDTA treatments. Timing of Mn application had no effect on FP, SMK, or TK; however, ELK, pod yield, and crop value were higher for the early application of MnEDTA. No significant differences were found for grade data between treatments and the control (Table 4). Pod yields were higher than the control for all early MnEDTA treatments (T1) and for the two higher rates for the late treatments (T2). For the early treatment (T1), crop value was greater than the control for all three MnEDTA rates. For the late treatment (T2), the 2.24 and 4.48 rates were greater than the control, but the 1.12 MnEDTA treatment did not differ from the control.

Rate × Timing Test in 1991. For the rate × timing test in 1991 using NC-V 11 and NC 7, neither MnEDTA rates nor time of application significantly affected grade except for the SMK in NC-V 11 (Tables 5 and 6). The SMK for the late treatment for NC-V 11 was higher than

Table 3. Grade, pod yield, and crop value data for peanut (NC-V 11) treated with foliar-applied MnEDTA in the 1990 rate test.

Treatment[b]	Grade factor[a]				Pod yield	Crop value
	FP[c]	ELK	SMK	TK		
kg ha^{-1}	%				kg ha^{-1}	\$ ha^{-1}
0.56 MnEDTA	67.5 b	40.5 a	71.5 a	74.3 a	2904 a*	2097 a*
1.12 MnEDTA	73.5 a**	45.0 a	70.8 a	73.5 a	3563 a**	2581 a**
1.68 MnEDTA	66.8 b	35.0 a	70.5 a	73.0 a	2983 a*	2137 a*
CV (%)	4.1	16.3	2.2	1.4	18.4	19.7
Control	59.0	42.3	72.8	75.0	1506	1119
Standard	72.0	36.5	67.8	72.2	3948	2747

[a]FP = fancy pods; ELK = extra large kernels; SMK = sound mature kernels; TK = total kernels.

[b]Treatments applied 7/2 and 7/17 for MnEDTA and 7/2, 7/17, and 8/1 for the standard.

[c]Unlike letters in any column indicate significate difference between treatments as determined by the Duncan's New Multiple Range Test at P = 0.05.

*,**Significant at P = 0.05 and 0.01, respectively, by the Dunnett's procedure. Superscript indicates comparison with the control and subscript indicates comparison with the standard.

Table 4. Grade, pod yield, and crop value data for peanut (NC-V 11) treated with foliar-applied MnEDTA in 1990 for the rate × timing test.

Time[a]	MnEDTA[b] ($kg\ ha^{-1}$) 1.12	2.24	4.48	Avg	CV %	Control	Standard
			Fancy Pods (%)				
T1	74.8	74.8	75.0	74.8 a	10.3	65.5	72.0
T2	66.8	69.0	71.8	69.2 a			
Avg	70.8 a	71.9a	73.4 a				
			Extra Large Kernels (%)				
T1	45.0$_{*}$	42.3	39.5	42.3 a	14.5	38.8	30.5
T2	36.0	34.8	39.0	36.6 b			
Avg	40.5 a	38.5 a	39.3 a				
			Sound Mature Kernels (%)				
T1	70.8	69.5	70.0	70.1 a	2.0	69.8	67.8
T2	68.3	69.5	70.0	69.3 a			
Avg	69.5 a	69.5 a	70.0 a				
			Total Kernels (%)				
T1	72.8$_{*}$	72.3	72.0	72.3 a	1.4	72.9	71.0
T2	71.5	72.0	72.5	72.0 a			
Avg	72.1 a	72.1 a	72.3 a				
			Pod Yield ($kg\ ha^{-1}$)				
T1	3862**	4210**	3918**	3997 a	7.6	3062	4077
T2	3587	3705*	3742*	3678 b			
Avg	3725 a	3958 a	3830 a				
			Crop Value ($\$\ ha^{-1}$)				
T1	2809**	3009**	2790*	2869 a	8.9	2196	2828
T2	2509	2664*	2680*	2618 b			
Avg	2659 a	2836 a	2735 a				

[a]T1 = start of first set of treatment applications; T2 = start of second set of treatment applications 2 wk after the first set; Avg = average of treatments.

[b]Unlike letters in any row or any column indicate significant difference between treatments as determined by the Duncan's New Multiple Range Test at P = 0.05 probability level.

*,**Significant at the P = 0.05 and 0.01 levels, respectively, by the Dunnett's procedure. Superscript indicates comparison with the control and subscript indicates comparison with the standard.

the early treatment (Table 5). Also, no differences existed between timing of application for pod yield or crop value in either cultivar.

Differences were detected between MnEDTA rate for pod yield and crop value in both cultivars. The 2.24 and 4.48 MnEDTA rates for NC-V 11 resulted in higher yields and had greater crop value than the low MnEDTA rate (Table 5). The 0.56, 1.12, and 1.68 MnEDTA treatments did not differ, but were lower than the 4.48 MnEDTA treatment. With NC 7 pod yield and crop value were lower for the 0.56 MnEDTA treatment as compared to the other treatments (Table 6). No treatment differences occurred in either cultivar with MnEDTA and the control or standard treatment for ELK and SMK, except for the 2.24 MnEDTA at T2 and the control for NC 7 (Tables 5 and 6). There were no differences in % TK between experimental treatments and the control for NC-V 11 or between experimental treatments and the standard or control for NC 7. The % TK of the 0.56, T1 and 1.12, T2 MnEDTA treatments were higher than the standard for NC-V 11 (Table 5). The % FP was higher for MnEDTA treatments than the control for both cultivars, except for the 0.56, T2 treatments for both cultivars and the 1.68, T2 treatment for NC-V 11 (Tables 5 and 6). Pod yield and crop value of the MnEDTA treatments were greater than the control for both cultivars except for the 0.56, T2 treatment for NC-V 11 which was not different than the control. NC-V 11 pod yields for the four highest treatments of T1 and the 1.12, 2.24, and 4.48 treatments of T2 were not different from the standard (Table 5). Crop value was lower than the standard for all treatments except the 2.24, T2 and 4.48, T2 treatments (Table 5). Pod yield and crop value for NC 7 were not different from the standard for the four highest MnEDTA treatments of T1 and T2 (Table 6). The pod yield and crop value for the lowest MnEDTA treatment (T1 and T2) were lower than the standard.

Pod Yield. All MnEDTA treatments had higher pod yields than the control during both years. In 1990, average pod yield increases for NC-V 11 were 109 and 25% greater than the control in the two tests. In 1991, average pod yield increases for NC-V 11 and NC 7 were 65 and 103% greater than the control, respectively. The highest yielding MnEDTA treatment in 1990 was the 2.25 MnEDTA, T1 which was 37% greater than the control. The highest yielding MnEDTA treatment for NC-V 11 in 1991 was 4.48 MnEDTA, T2 which was 99% greater than the control. The highest yielding MnEDTA treatment (4.48, MnEDTA, T2) for NC 7 in 1991 was 133% greater than the control. The highest yielding MnEDTA treatments for the NC-V 11 and NC 7 were not different than the standard.

Crop Value. The crop values were similar to pod yield results when compared to the control and standard treatments. In this test grade factors did not have any influence on crop value.

Discussion

Growing Seasons. Rainfall conditions and heat unit accumulations were more favorable for peanut production during 1991 than 1990. The approximate 39% yield increase of the standard treatment for NC-V 11 in 1991 over that of 1990 reflects the more favorable year for peanut production in 1991.

Grade Factors. Grade factors most affected by foliar-applied MnEDTA were FP and ELK. In 1990, the % ELK for the different treatments did not differ from the control; however, treatments which had the greatest pod yields also had a greater % ELK. In 1991, the % ELK was greater than the control for all MnEDTA treatments, which may be attributed to the more favorable growing season. During both growing seasons the % TK and % SMK were not different from the control. MnEDTA

Table 5. Grade, pod yield, and crop value data for peanut (NC-V 11) treated with foliar-applied MnEDTA in 1991 for the rate × timing test.

	MnEDTA[b] (kg ha^{-1})								
Time[a]	0.56	1.12	1.68	2.24	4.48	Avg	CV %	Control	Standard
				Fancy Pods (%)					
T1	68.0^{*}_{*}	68.0^{*}_{*}	66.5^{*}_{**}	70.0^{**}	72.0^{**}	68.9 a	6.5	56.1	77.2
T2	65.8_{**}	69.8^{**}	65.8_{**}	71.8_{**}	70.0_{**}	68.6 a			
Avg	66.9 a	68.9 a	66.1 a	70.9 a	71.0 a				
				Extra Large Kernels (%)					
T1	46.3	41.5	37.8	40.8	40.8	40.8 a	7.5	36.7	40.3
T2	37.8	42.3	41.5	42.3	39.5	40.7 a			
Avg	40.5 a	41.9 a	39.6 a	41.5 a	40.1 a				
				Sound Mature Kernels (%)					
T1	71.3	70.0	69.0	69.8	70.5	70.1 b	2.1	71.2	71.0
T2	70.0	72.0	71.8	72.0	70.3	71.2 a			
Avg	70.6 a	71.0 a	70.4 a	70.9 a	70.4 a				
				Total Kernels (%)					
T1	76.0_{*}	75.0	74.4	75.2	75.5	75.2 a	1.0	76.1	74.4
T2	75.3	76.1_{*}	75.6	75.4	74.6	75.4 a			
Avg	75.7 a	75.5 a	75.0 a	75.3 a	75.1 a				
				Pod yield (kg ha^{-1})					
T1	4286^{*}_{*}	4313^{*}	4500^{**}	4854^{**}	4799^{**}	4551 a	13.3	2820	5575
T2	3796_{**}	4444^{**}	4273^{*}_{*}	5033^{**}	5603^{**}	4630 a			
Avg	4041 c	4379 bc	4686 bc	4944 ab	5201 a				
				Crop Value (\$ ha^{-1})					
T1	3268^{*}_{**}	3236^{*}_{**}	3344^{*}_{**}	3636^{**}_{**}	3648^{**}_{**}	3426 a	13.9	2127	4216
T2	2848_{**}	3438^{*}_{**}	3288^{*}_{**}	3880^{**}	4239^{**}	3537 a			
Avg	3058 c	3337 bc	3315 bc	3757 ab	3942 a				

[a]T1 = start of first set of treatment applications; T2 = start of second set of treatment applications 2 wk after the first set; Avg = average of treatments.

[b]Unlike letters in any row or any column indicate significant difference between treatments as determined by the Duncan's New Multiple Range Test at the P = 0.05 probability level.

*,**Significant at P = 0.05 and 0.01 levels, respectively, by the Dunnett's procedure. Superscript indicates comparison with the control and subscript indicates comparison with the standard.

treatments had higher % FP than the control for both years and cultivars. In 1990, the differences in % FP among MnEDTA treatments and the control were not significant except for one treatment (1.12 MnEDTA, rate test). In 1991, however, the % FP for all treatments except three (0.56 MnEDTA, T2, NC-V 11, and NC 7; 1.68 MnEDTA, T2, NC-V 11) was greater than the control. This demonstrated the importance of good Mn nutrition for fancy size pod development of the virginia-type peanut. These results for the ELK and SMK are similar to those reported by Hallock (1979) for the cultivar Florigiant.

MnEDTA Required. This research demonstrated that foliar applications of 2.24 to 4.48 kg ha^{-1} of MnEDTA (13% Mn) or 0.29 to 0.58 kg ha^{-1} of Mn in the EDTA chelate form per application is required to overcome Mn deficiency in peanut. However, MnEDTA is not better than the standard. Initial application should start at 4-6 wk after planting and two additional applications should follow at 2-wk intervals.

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Table 6. Grade, pod yield, and crop value data for peanut (NC 7) treated with foliar-applied MnEDTA in 1991 for the rate × timing test.

	MnEDTA[b] (kg ha^{-1})								
Time[a]	0.56	1.12	1.68	2.24	4.48	Avg	CV %	Control	Standard
				Fancy Pods (%)					
T1	82.5*	83.0*	85.8**	84.5**	84.5**	84.1 a	5.8	72.3	86.6
T2	80.5	82.5*	83.5*	82.8*	85.8**	83.0 a			
Avg	81.5 a	82.8 a	84.6 a	83.6 a	85.1 a				
				Extra Large Kernels (%)					
T1	53.0	53.8	50.5	55.0	53.0	53.1 a	10.0	44.3	52.3
T2	52.5	52.5	52.5	56.8*	53.3	53.5 a			
Avg	52.8 a	53.1 a	51.5 a	55.9 a	53.1 a				
				Sound Mature Kernels (%)					
T1	71.3	70.8	70.5	71.0	69.8	70.7 a	2.3	69.2	69.4
T2	71.0	71.3	69.8	69.0	70.5	70.3 a			
Avg	71.1 a	71.0 a	70.1 a	70.0 a	70.1 a				
				Total Kernels (%)					
T1	75.8	75.7	75.2	75.7	75.1	75.5 a	1.10	76.0	74.6
T2	75.7	76.1	75.9	75.2	75.8	75.7 a			
Avg	75.7 a	75.9 a	75.6 a	75.4 a	75.4 a				
				Pod yield (kg ha^{-1})					
T1	3893$^{**}_{**}$	4501**	4595**	4861**	4676**	4506 a	11.6	2262	5451
T2	3830$^{**}_{**}$	4766**	4716**	4689**	5279**	4676 a			
Avg	3911 b	4633 a	4656 a	4776 a	4977 a				
				Crop Value ($ ha^{-1})					
T1	2917$^{**}_{*}$	3416**	3433**	3695**	3480**	3389 a	12.0	1692	4016
T2	2949$^{**}_{*}$	3584**	3569**	3485**	3969**	3512 a			
Avg	2934 b[c]	3500 a	3500 a	3589 a	3725 a				

[a]T1 = start of first set of treatment applications; T2 = start of second set of treatment applications 2 wk after the first set; Avg = average of treatments.

[b]Unlike letters in any row or any column indicate significant difference between treatments as determined by the Duncan's New Multiple Range Test at the P = 0.05 probability level.

*,**Significant at P = 0.05 and 0.01 levels, respectively, by the Dunnett's procedure. Superscript indicates comparison with the control and subscript indicates comparison with the standard.

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