EFFECTS OF FOLIAR FERTILIZATION AND FUNGICIDE APPLICATIONS ON YIELD AND GRADE OF PEANUTS (<u>ARACHIS HYPOGAEA L.</u>)

By

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PEANUTS (*ARACHIS HYPOGAEA L.*)

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CHAPTER I

Introduction

Although the exact origin of the peanut (Arachis hypogaea L.) is still the subject of scientific inquiry, it is an important food crop. The seed of the peanut may be boiled, broiled, roasted, crushed, ground, or mixed with other foods. In other countries, the peanut is used to make a beer and other non alcoholic drinks. With such a plant whose products are so versatile, the possibility of increasing peanut yields is indeed a noble goal.

In Oklahoma, the peanut represents one of the top three cash crops with 46 million dollars worth of peanuts produced during the 1983 growing season. Oklahoma ranks sixth in the United States in peanut-producing states with approximately 36.5 thousand hectares producing an average of 2,240 kg ha^{-1} of farmer stock peanuts. The conventional system of peanut fertilization employs preplant fertilization. But, the idea of supplying needed nutrients at a time when those nutrients could best be utilized by a growing plant has wide appeal. Much work has been reported indicating that foliar applied fertilizers have resulted in varying degrees of success.

In unpublished research the use of a fungicide in conjunction with a foliar applied fertilizer has been recommended. In Oklahoma Cercospora leaf spot has been estimated to cost approximately $345,000 in annual production losses. Therefore, fungicide treatments were included with foliar fertilizers in this study. With these thoughts in mind, experiments were established to address the effects of foliar applied fertilizers and fungicide applications on yield and grade of peanuts.

CHAPTER II

LITERATURE REVIEW

The appeal of applying nutrients as required by plant demand has increased interest in foliar application techniques. The success of such applications with respect to micronutrient additions are well known and have encouraged research in foliar application of macronutrients. The peanut plant is like other crops in that it requires an adequate supply of essential elements to be available throughout the growing season for maximum yields to be obtained. In an effort to supply needed nutrients to the plant, and at critical times in life of the plant, foliar sprays have been utilized. The use of foliar sprays is appealing due in part to the ability of the plant leaf to absorb needed nutrients. The effects of timing on germination and seed quality were also considered. Attention was given to foliar sampling techniques in order to determine their usefulness in predicting critical application times or effects of application time. The control of Cercospora leafspot was also considered due to its reported enhancement of quality. It is the purpose of this literature review to explore the use of foliar applied nitrogen (N), phosphorus (P), and potassium (K) alone and in combination with foliar fungicides. Emphasis is given to such research involving peanuts (Arachis hypogaea L.) with important examples involving other commodity crops.

Nutrient Uptake via the Leaf

There are apparently several different entry points into leaf and shoot cells through which foliar applied nutrients may enter. Wittwer and Teubner (1958) reported in their review article that nutrient absorption occurs in all plant parts to some degree. However, most nutrients enter through the leaf surface with additional entry through the cuticle, imperfections in the leafx such as cuts or insect incisions; open stomata, or ectodesmata.

Neither spray contact angle nor surface active agents with foliar sprays play a dominant role in uptake of nutrients (Wittwer and Teubner, 1958).

As liquid fertilizer is dispensed upon the exposed upper surfaces of the plant, the normal nutrient pathway via the root to the leaf may become less imporant. This alternate pathway requires less metabolic activity than the primary root sorption pathway. Peanuts grown in nutrient solutions with varying amounts of salinity, as NaCl, showed adverse effects of salinity by lowered levels of RNA and DNA (Malakondaia and Rajeswararao, 1979b). Also, foliar application of a phosphate-containing fertilizer increased both RNA and DNA levels over plants grown in saline conditions only. Malakondaia and Rajeswararao (1979a) concluded that plants grown under a saline condition in which root-P absorption was retarded could be supplied with P by foliar application and partially overcome the growth retarding effects of salinity.

Timing and Effects of Foliar Feeding

Hallock (1980), reporting on foliar application of nutrients and their effect on mineral composition and seed germination, indicated highest germination of peanut seed from plots where gypsum had been soil-applied. Seed germination was decreased in plants that had been previously foliar fertilized when compared to the control. Cox (1972), reported similar effects on germination. In addition, he observed that peanut yield from foliar-applied Ca was only 1/16th of that from soil-applied gypsum. Nitrogen and P leaf concentrations have been shown to decrease with plant age while K increases during the early part of the growing season then decreases (Cox et al. 1970). Nutrient concentrations appear to be influenced greatly by plant physiological age, part sampled, and by soil heterogeneity. Mehlich (1971) reported that nutrient addition during seed development may decrease peanut quality and recommended not adding nutrients beyond this critical point.

Fertilization of Peanuts

Peanuts require that an adequate supply of essential elements be available throughout the growing season to obtain maximum yields. Badiger et al. (1982) in a greenhouse pot study, reported significant responses from groundnut to applications of K at 5 mg kg^{-1} of soil with and without added Ca. The interaction of nutrients appears to be varied. Yield, sound mature kernels (SMK), and extra large kernels (ELK) of Bunch peanuts increased with Ca fertilization on Fuquay and Tifton loamy sand but not on Greenville sandy loam in work reported by Walker et al. (1979). Balwinder and

Rana (1979) reported a linear response to applied-P on pod and straw yield on P-deficient soils. On soils testing medium to high in P availability, significant response was obtained from P applications of up to 6.5 mg P kg^{-1} and 4.3 mg P kg^{-1} respectively for pod and straw yield. Walker et al. (1974) indicated that runner peanuts showed no significant yield increase to additions of N. Only spanish varieties responded to 22.4 kg N ha^{-1} on this soil. They further reported no increase in yield of peanut due to added P or K.

Foliar Sprays

In an effort to supply nutrients to peanuts at critical growth periods, much research has been directed toward the use of foliar-applied nutrients with varying success. Reddy et al. (1973) in research conducted in India, showed applications of 8.7 kg P ha^{-1} foliar-applied and 26.1 kg P_2O_5 soil-applied increased yields significantly. The former rate was found to be more economical than the latter rate. Pancholy et al. (1982) reported no significant difference in yield due to foliar or soil applications of urea. Although peanut quality was not measured in this study, the levels of three amino acids most commonly deficient in peanuts were increased by urea addition (Pancholy et al. 1979). Walker et al. (1975) reported an increase in yield occurred only with multiple foliar applications of S to Florunner peanuts. Foliar-applied urea increased total yield but higher urea rates had a negative effect on peanuts in studies conducted by Pancholy and Guy (1979).

Walker and Ethredge (1974) reported that rate and time-of-application of N fertilizer had no signficant effect on yield, grade, or seed-N content in 'Starr' peanuts grown in three different soil types. Working on soybeans (Glycine max L., Merr.), Boote et al. (1978) reported that foliar fertilization applied during seed-fill did not significantly affect yield, extend gross photosynthesis duration, or delay maturity in 'Bragg' soybeans. Nagel et al. (1979) treated 'Cobb' soybean foliage with Folian, a formulation produced by Allied Chemical Company. No significant yield effects were noted. However, leaf damage did occur in the upper canopy with repeated sprayings. In a separate experiment, morning applications of foliar fertilizer significantly decreased yield of Cobb soybeans compared to untreated plants. Afternoon applications had no effect upon yield. Robertson et al. (1977) discouraged the use of foliar-applied N-P-K-S fertilizer mixtures, since they reported no significant difference in soybean yields grown under three water management regimes.

Walker et al. (1974) have also reported that botanical varieties differ in their response to applied fertilizer. Other studies indicated that sequentially branched varieties may be more responsive than alternately branched varieties (Mukhtar and Yousif, 1979).

Foliar Sampling for Plant Nutrient Content

For optimum crop production, nutrient deficiencies should be identified and corrected quickly to prevent decreased yields. Plant sampling is considered to be the most satisfactory method for early detection of nutrient deficiencies. Hallock et al. (1969) recommended the first and second lateral branch leaves be sampled. Phosphorus and K can best be determined by ultilizing the upper central stem leaves and the first lateral branch leaves (Hallock et al. 1971). Nutrient levels were identified by sampling only the upper main stem leaves. Blades and petiole portions of the peanut plant should be sampled separately and sampling date should be taken into consideration when sampling for particular nutrients (Hallock et al. 1972).

Leafspot Control and Quality

Middleton and Littrell (1981) reported that fungicide deposition was enhanced by use of controlled droplet application equipment when applying the widely used fungicide Chlorothalonil (Bravo). The use of a spray adjuvant did not effect deposition while the full rate of Chlorothalonil depressed yields. Chlorothalonil treatment controlled leafspot caused by (Cercosporidium personatum) even at the lowest application rate. Hammond et al. (1976) measured less defoliation and infection on Chlorothalonil-treated plots than on untreated plots. While Chlorothalonil-treated peanuts were of significantly higher quality than peanuts treated with other fungicides, the quality of untreated peanuts was significantly better than all fungicide-treated peanuts (Hammond et al. 1976).

CHAPTER III

MATERIALS AND METHODS

The Caddo County Research Station, Ft. Cobb, Oklahoma, was selected for a series of experiments to be conducted during both the 1980 and 1981 peanut growing seasons to study the effects of commercially available foliar-applied fertilizers and a fungicide. The soil on which these experiments were conducted was a Meno loamy fine sand, Aquic Arenic Haplustalf. Initial soil test parameters are given in Table I. Experiments were arranged in a randomized complete block design with four replications. 'Florunner' peanuts (Arachis hypogaea L.), botanical type Virginia, were planted in 0.9 m rows. Peanuts were planted for all experiments on May 28, 1980, and May 14, 1981, using a John Deere Flex-71 four-row planter. The 1980 plots were 30.5 m in length. However, the 1981 plots used in Experiment 1 were shortened to 15.3 m to allow for additional treatments. Irrigation of both experiments was as required using a side-roll sprinkler irrigation system. No soil moisture data were taken, but peanuts showed no visual signs of moisture stress.

Leaf samples were taken 20 to 25 days after planting, 60 to 65 days after planting, and one week prior to harvest. Nitrogen concentration of the leaves was determined using a modified Kjeldahl technique with a sample weight of 0.250 g. Phosphorus

TABLE I

SOIL TEST INDICES FOR MENO LOAMY FINE SAND

ELEMENT	INDEX
pH	7.3
NO3-N 1/	6.3 kg ha^{-1}
P	69 kg ha^{-1}
K	274 kg ha^{-1}
Ca	1453 kg ha^{-1}
Mg	149 kg ha^{-1}
Zn	0.55 mg/g
Fe	17.43 mg/g
Mn	6.3 mg/g
B	0.64 mg/g

1/ All nutrients are considered adequate based upon Oklahoma State Univ. Fact Sheet No. 2225 (Johnson and Tucker, 1981). The indices conform to those utilized in Fact Sheet No. 2225.

and K leaf concentration were determined by nitric-perchloric digestion and colorimetric and atomic absorption techniques, respectively. All analyses were determined in duplicate. Peanuts were removed from the soil using a Lilliston two-row digger/inverter on October 13, 1980, and November 1, 1981. All peanuts were dug and a Lilliston peanut combine harvested the center two rows of each four row plot on October 22, 1980, and November 11, 1981. Peanuts were sacked in the field and a two minute waiting period was allowed for nut clearance from the combine between each plot. All peanuts from these two rows were weighed and air dried. A subsample was sent to the Federal State Inspection Service, for grading. Chemical herbicides were applied by research station personnel before planting and competition by weeds was not evident.

All statistical analyses were calculated using the Statistical Analysis System (SAS, 1982) employing analysis of variance, means, and plot procedures. Data handling was accomplished using the data management system designed by Hanlon and Westerman (1984). Data were analyzed as a randomized complete block design and a protected LSD test was used to rank means where applicable.

Experiment I

Experiment I was conducted in both 1980 and 1981 and utilized foliar applications of commercial fertilizers formulated by Allied Chemical. In 1980, five applications of the liquid fertilizer marketed under the trade name Folian were made at the rate of 23.4 l ha^{-1}, each. This product contained 12% N, 1.7% P, and 3.3% K. In 1981, another product, also marketed by Allied Chemical, containing 9% N, 4.8% P, and 5.4% K, was added in plots adjacent to the existing 1980 treatments. To control Cercospora leaf spot, two levels of a foliar fungicide, Chlorothalonil, trade name Bravo, were applied in a complete factorial arrangement of treatments with both fertilizer sources. A complete list of fertilizer and fungicide treatments for both 1980 and 1981 is shown in Table II. Both the fungicide and fertilizer were mixed and applied simultaneously. In 1980, the first two treatments employed a tractor mounted boom type sprayer, while the remaining three treatments were applied with a bicycle sprayer using compressed air propellant. Spray nozzles of either device were centered over each of the four rows within a plot. The bicycle sprayer was used for the latter applications to reduce damage to the Florunner peanuts as the plants grew into the row middles. All treatments in 1981 were applied with the tractor mounted sprayer. Visual inspection of machine caused damage revealed only minor foliage losses.

Experiment II

Experiment II was conducted only in 1980. Foliar applications were made using a commercial liquid fertilizer marketed by Nachurs, Inc. This product contained 10% N, 4.4% P, and 8.3% K and was applied at the rate of 23.4 l ha^{-1}.

TABLE II

LIST OF TREATMENTS FOR EXPERIMENT I, 1980 AND 1981

Number	Treatment Source	Rate	1980	1981
1	Check	-	x	x
2	Chlorothalonil	1.17 l ha^{-1}	x	x
3	Chlorothalonil	2.34 l ha^{-1}	x	x
4	12-1.7-3.3 1/	2.34 l ha^{-1} 2/	x	x
5	12-1.7-3.3 and Chlorothalonil	1.17 l ha^{-1}	x	x
6	12-1.7-3.3 and Chlorothalonil	2.34 l ha^{-1}	x	x
7	9-4.8-5.4 and Chlorothalonil	2.34 l ha^{-1} 2/	-	x
8	9-4.8-5.4 and Chlorothalonil	1.17 l ha^{-1}	-	x
9	9-4.8-5.4 and Chlorothalonil	2.34 l ha^{-1}	-	x
10	Check		-	x

1/ Expressed on an elemental basis
2/ 5 applications

Study 1. Application Time of Day

To measure the effect of application of the foliar fertilizer at different times during the day, Study 1 included applications at 6 am, noon, and 8 pm. Each treatment consisted of only one application and time-of-day combination. Five application dates, based upon three-week increments measured from date of planting, were selected. Table III shows the exact dates and treatment numbers used in this study.

Study 2. Application Number

The effect of number of applications was addressed by applying the commercial label recommended rate of 23.4 $l\ ha^{-1}$ one to five times during the 1980 growing season. The application dates correspond to those application dates used in Study 1 and a treatment listing is found in Table III.

Experiment III

Experiment III was conducted in 1981 to measure the effects, if any, of several commercially formulated fertilizers. Five treatments of each fertilizer were made at approximately two week intervals. Table IV delineates the various fertilizers and rates that were applied in this experiment. Rates were selected based upon the fertilizer label recommended value and 2x that value.

TABLE III

LIST OF TREATMENTS FOR EXPERIMENT II: STUDIES 1 AND 2, 1980

Treatment Number	Weeks After Planting 3	6	9	12	3 Weeks Prior to Harvest
1 (Check)	-	-	-	-	-
2	a 1/	-	-	-	-
3	b 2/	-	-	-	-
4	c 3/	-	-	-	-
5	-	a	-	-	-
6	-	b	-	-	-
7	-	c	-	-	-
8	-	-	a	-	-
9	-	-	b	-	-
10	-	-	c	-	-
11	-	-	-	a	-
12	-	-	-	b	-
13	-	-	-	c	-
14	-	-	-	-	a
15	-	-	-	-	b
16	-	-	-	-	c
17	c	c	-	-	-
18	c	c	c	-	-
19	c	c	c	c	-
20	c	c	c	c	c

1/ 6:00 a.m.
2/ 12:00 p.m.
3/ 8:00 p.m.

Note: Treatments 2 through 20 received product containing 10% N, 4.4% P, and 8.3% K applied at rate of 23.4 l ha^{-1} on dates and times indicated.

TABLE IV

LIST OF TREATMENTS FOR EXPERIMENT III, 1981

Treatment		Rate ($l\ ha^{-1}$)
1	Check	
2	12-1.7-3.3	2.34
3	12-1.7-3.3	4.68
4	10-4.8-5.4	2.34
5	10-4.8-5.4	4.68
6	9-7.8-5.3	2.34
7	9-7.8-5.3	4.68
8	3-7.8-10.6	2.34
9	3-7.8-10.6	4.68
10	28-0-0	7.00
11	28-0-0	14.00
12	9-4.8-5.8	2.34
13	9-4.8-5.8	4.68

CHAPTER IV

RESULTS AND DISCUSSION

When considering the amounts of nutrients applied by foliar application, sufficient nutrients could not be supplied to plants growing in a low fertility soil. Nitrogen has been shown to increase yields of Spanish peanuts but the increase in yield seldom offsets the increased cost (Tucker and Tripp, 1971). Phosphorus and K on Oklahoma soils used to produce peanuts may range from 22 to 90 kg ha^{-1} of P_2O_5 and 34 to 75 kg ha^{-1} of K_2O (Johnson and Tucker, 1981). Since needed foliar applications in low fertility situations will be numerous, this application method may not be economical. The best case for utilizing foliar applications may be made where deficiencies of N, P, and K are relatively small. If we determine through soil testing that the soil is 90% sufficient for P and K, recommendations from Oklahoma State University would specify 17 to 21 kg ha^{-1} of P_2O_5 and 21 to 34 kg ha^{-1} of K_2O. These lower amounts could be applied in three to five foliar applications depending on fertilizer source (Tucker and Tripp, 1971).

The 1980 soil test values, reported in Table I, for Experiments I, II, and III revealed 7 kg ha^{-1} of NO3-N, P soil level was 95% sufficient, and the K level was 100% sufficient. Soil test levels in 1981 were within the same range showing no soil-nutrient accumulation from the 1980 foliar fertilizer additions. Due to the small amounts of nutrients applied directly to the foliage (see Table V), accumulation was not anticipated.

Recommendations from Oklahoma State University (Johnson and Tucker, 1981) regarding peanut fertilization indicate 11.2 to 22.4 kg N ha^{-1} are required for peanut establisment. Phosphorus and K recommendations for soils that are 95% and 100% sufficient, respectively, are 16.8 to 22.4 kg P ha^{-1} and no requirement of additional K. Treatments in Experiments I, II, and III utilized varying rates of N, P, and K (see Table V) and supplied levels consistent with those needed to obtain good yeilds. Yet when compared to check plots, no significant differences were obtained in peanut yield or quality. These findings appear to be consistent with reported research for peanuts and other crops (Boote, et al. 1978; Nagel, et al. 1979; Pancholy et al. (1982). It is further postulated that no response would be anticipated on soils where soil test indices are in an adequate range (Walker and Ethredge, 1974). Johnson (1980) was unable to show a significant response to method and rate of application of fertilizer to peanuts in Oklahoma soils where soil test indices were high. In Experiments I, II, and III, no statistical or agronomic significant difference was found in yield or sound mature kernels no matter how many foliar fertilizer applications, time of day applications, or combinations with fungicide were applied.

Experiment I: Foliar Fertilizer and Fungicide

The effect of sampling date had a significant effect upon

TABLE V

NUTRIENT RATES PER APPLICATION IN EXPERIMENTS I, II AND III

		Nutrients (kg ha^{-1})		
Treatment	Experiment	N	P	K
4	I	3.26	.47	.90
5	I	3.26	.47	.90
6	I	3.26	.47	.90
7	I	2.75	1.47	1.77
8	I	2.75	1.47	1.77
9	I	2.75	1.47	1.77
2 through 20	II	2.39	1.04	1.99
2	III	3.26	.47	.90
3	III	6.52	.95	1.80
4	III	2.99	1.31	2.49
5	III	5.99	2.62	4.98
6	III	2.79	2.44	2.32
7	III	5.59	4.88	4.64
8	III	.99	2.59	9.87
9	III	1.98	5.19	9.87
10	III	2.52	-	-
11	III	5.03	-	-
12	III	2.75	1.47	1.77
13	III	5.50	2.93	3.54

Fertilizer contained 0.5% Sulfur

leaf nutrient concentrations measured in 1980. This finding is in agreement with the known physiological changes occurring within the peanut leaf as it matures. For example, the data in Table VI reflect the accumulation of N in the leaf at 22 and 64 days after planting and a decrease of approximately 50 percent just prior to harvest. While N-concentration of the seed was not measured in this study, other researchers have reported a transfer of N from the leaf to the seed during this growth period (Cox et al. 1979).

Visual ratings of the effect of Chlorothalonil reflected no significant differences from the check plots (data not shown). A low infestation of Cercospora leafspot in all plots was noted in both 1980 and 1981.

No significant treatment effects from foliar fertilization were observed in 1980. Peanut yields and SMK values are reported in Table VII.

Experiment I: 1981

Nutrient concentrations in leaves sampled 65 days after planting and 1 week prior to harvest are shown in Tables VIII and IX, respectively. Leaf-N again appeared significant when compared to check but values appear to be in line with the findings of other researchers in that total N concentration in peanut leaves continually decreased with time, with the exception of a slight increase between 5 and 7 weeks growth. Peanut leaf samples taken at 20 to 25 days after planting were inadvertently destroyed by malfunction in the plant drying oven and were burned up.

TABLE VI

NITROGEN CONCENTRATION IN FLORUNNER PEANUT LEAVES AT THE THREE SAMPLING DATES, EXPERIMENT I, 1980

		N Concentration, mg/g		
		--Days After Planting--		1 week prior to harvest
Source	Rate	22	64	
Check		6.5	8.1	4.9
Chlorothalonil	1.17 l ha^{-1}	6.6	8.0	4.8
Chlorothalonil	2.34 l ha^{-1}	6.5	7.9	4.8
12-1.7-3.3 1/	2.34 l ha^{-1}	6.6	8.2	4.9
12-1.7-3.3 and Chlorothalonil	1.17 l ha^{-1}	6.6	7.9	4.9
12-1.7-3.3 and Chlorothalonil	2.34 l ha^{-1}	6.6	8.0	4.3
		NS	NS	NS

1/ Expressed on an elemental basis
NS denotes non significance at P = 0.05 level of probability.

TABLE VII

YIELD AND SOUND MATURE KERNELS OF FLORUNNER PEANUTS, EXPERIMENT I, 1980

Source	Rate	Yield ($Mg\ ha^{-1}$)	SMK Rating %
Check		3.16	71.5
Chlorothalonil	1.17 l ha^{-1}	2.83	73.0
Chlorothalonil	2.34 l ha^{-1}	3.10	72.0
12-1.7-3.3 1/	2.34 l ha^{-1}	3.37	71.7
12-1.7-3.3 and Chlorothalonil	1.17 l ha^{-1}	2.90	71.5
12-1.7-3.3 and Chlorothalonil	2.34 l ha^{-1}	2.85	70.5
		NS	NS

1/ Expressed on an elemental basis
NS denotes non significance at P = 0.05 level of probability.

TABLE VIII

NITROGEN, P, AND K CONCENTRATIONS IN FLORUNNER PEANUT LEAVES SAMPLED 65 DAYS AFTER PLANTING, EXPERIMENT I, 1981

Source	Rate	N	P	K
		------Concentration---------		
		---------($mg\ g^{-1}$)----------		
Check		7.5	0.10	1.47
Chlorothalonil	1.17 l ha^{-1}	7.4	0.09	1.42
Chlorothalonil	2.34 l ha^{-1}	7.7	0.10	1.48
12-1.7-3.3 1/	2.34 l ha^{-1}	7.5	0.09	1.50
12-1.7-3.3 and Chlorothalonil	1.17 l ha^{-1}	7.7	0.10	1.45
12-1.7-3.3 and Chlorothalonil	2.34 l ha^{-1}	7.8	0.09	1.30
9-4.8-5.4	2.34 l ha^{-1}	7.7	0.10	1.44
9-4.8-5.4 and Chlorothalonil	1.17 l ha^{-1}	7.7	0.10	1.48
9-4.8-5.4 and Chlorothalonil	2.34 l ha^{-1}	7.3	0.09	1.48
Check		7.5	0.09	1.48
		NS	NS	NS

1/ Expressed on an elemental basis.
NS denoted non significance at P = 0.05 level of probability.

TABLE IX

NITROGEN, P, AND K CONCENTRATIONS IN FLORUNNER PEANUT LEAVES ONE WEEK PRIOR TO HARVEST, EXPERIMENT I, 1981

Source	Rate	------Concentration----- N	P -------($mg\ g^{-1}$)-------	K
Check		4.6	0.05	0.79
Chlorothalonil	1.17 l ha^{-1}	4.6	0.05	0.79
Chlorothalonil	2.34 l ha^{-1}	4.8	0.05	0.81
12-1.7-3.3 1/	2.34 l ha^{-1}	4.7	0.05	0.82
12-1.7-3.3 and Chlorothalonil	1.17 l ha^{-1}	4.7	0.05	0.82
12-1.7-3.3 and Chlorothalonil	2.34 l ha^{-1}	4.9	0.05	0.74
9-4.8-5.4	2.34 l ha^{-1}	4.7	0.05	0.83
9-4.8-5.4 and Chlorothalonil	1.17 l ha^{-1}	4.6	0.05	0.76
9-4.8-5.4 and Chlorothalonil	2.34 l ha^{-1}	4.7	0.05	0.79
Check		4.7	0.05	0.84
		NS	NS	NS

1/ Expressed on an elemental basis.
NS denotes non significance at P = 0.05 level of probability.

Also, unseasonably cool temperatures slowed plant growth, which accounts for the extended growing season.

Cercospora leafspot was visually rated again in 1981 and no significant differences from check plots were noted. Neither yield nor SMK values showed any response to Chlorothalonil addition.

According to soil test indices, optimum soil fertility conditions existed since no significant effects were noted. There also appears to be no synergistic effect between foliar fertilization and fungicide applications. Possible reasons for these negative results might be found in the low disease infestation due to dry conditions in 1980. Further, the soil fertility conditions appeared to be at adequate levels for optimum peanut growth without the use of foliar applied fertilizer.

Experiment II: Time-of-Day, 1980

No significant difference from the control was found in leaf N, P, or K for samples taken at 60 to 65 days after planting. Tables X and XI depict these data, showing field uniformity as well. Leaf P was elevated depending upon time of day application at 1 week prior to harvest (Table XI). No differences were noted for leaf N or K, however.

Experiment II: Application Date, 1980

Data from this experiment are displayed in Table XII. Leaf nutrient concentration apppears to decrease when foliar

TABLE X

EFFECT OF TIME OF DAY APPLICATIONS ON N, P, AND K CONCENTRATIONS IN FLORUNNER PEANUT LEAVES, EXPERIMENT II, 1980

Time of Day	-------Concentration--------		
	N	P	K
	---------($mg\ g^{-1}$)---------		
6 a.m.	4.25	3.04	189.86
Noon	4.25	3.32	193.20
8 p.m.	4.29	3.08	178.32
Check	4.13	3.13	185.90
	NS	NS	NS

NS denotes non-significance at P = 0.05 level of probability.

TABLE XII

EFFECT OF TIME OF DAY APLICATION ON P CONCENTRATION IN FLORUNNER PEANUT LEAVES ONE WEEK PRIOR TO HARVEST, EXPERIMENT II, 1980

Time of Day	Concentration N	Concentration P	Concentration K
	---------(mg g^{-1})--------		
6 a.m.	28.15 A 1/	1.57 A	107.89 A
Noon	28.88 A	1.56 A	106.31 A
8 p.m.	28.61 A	1.51 B	106.27 A
Check	29.43 A	1.59 A	102.69 A
LSD (0.05)	NS	0.04	NS

1/ Means followed by the same letter are not significantly different at P = 0.05 level of significance.

NS denotes non significance at P = 0.05 level of probability.

TABLE XII

EFFECT OF APPLICATION DATE ON N, P, AND K CONCENTRATIONS IN FLORUNNER PEANUT LEAVES

Application Date	Concentration N	P	K
	(mg g^{-1})		
First	29.55 A 1/	1.60 A	106.00 B
Second	29.17 A	1.59 A	104.49 B
Third	28.20 B	1.51 BC	104.22 B
Fourth	27.02 B	1.48 C	107.16 AB
Fifth	28.73 A	1.55 AB	106.00 A
Check	29.43 A	1.59 A	102.69 B
LSD 0.05 =	1.56	0.06	5.83

1/ Means followed by the same letter are not significantly different at the 0.05 probability level.

applications are made later in the growing season. Thus, the date of foliar application influences the nutrient levels within the plant.

There are a number of conditions conducive to obtaining a response from foliar N fertilizers (Pancholy and Guy, 1979; Pancholy et al. 1982; Tucker and Tripp, 1971; Walker et al. 1974). Other studies have measured responses from the addition of P and K as well but a majority of these responses were obtained in low fertility soils (Balwinder and Rana, 1979; Goud Reddy et al. 1973) Possible reasons for the various responses may be based on the changing physiological demands of the plant with growth stages. Other factors to consider are conditions that might cause plant stress, such as moisture availablity or low soil nutrient availability.

Even though a significant difference in leaf nutrient concentration was found at different application dates, the increase in nutrient concentration did not result in higher yield or improved quality.

Experiment II: Number of Applications, 1980

All N, P, and K leaf concentration data revealed no significant differences when compared to check plot data. Although these results appear to conflict with application date results, it should be remembered that plant leaf levels in both studies indicate growth is occurring in adequate or luxurious consumption ranges. No significant differences were noted in either yield or crop quality of Florunner peanuts, indicating no economic advantage to one or more foliar applications in this study.

Experiment III: Source and Rate, 1981

The data from this experiment are displayed in Table XIII. No significant effects of either fertilizer source or rate were noted on yield or quality ratings.

These responses are as predicted when a high fertility soil is considered and further support the finding of this thesis. Although Goud Reddy et al. (1973) reported no soil test values, it was stated that a basal dose of N and K and required phosphate was applied to the plots at the time of land preparation. Goud Reddy et al. (1973) did show a response to application of 8.6 kg P ha^{-1} foliar spray and 25.8 kg ha^{-1} of P soil applied. Their findings stated an increase in yield and higher economic return was achieved by foliar application. These data do not contradict, but further support, the idea that foliar application of macronutrients is of little or no benefit on fertile soils. Goud Reddy et al. (1973) reported a significant positive response at 8.6 kg P ha^{-1}, but when the foliar application rate was increased to 12.9 kg P ha^{-1}, peanut yields decreased below check yields. If P had been soil applied, a portion would have remained in the soil for future crop use (Colwell et al. 1946). Also, the response received was low when yield data is considered. The highest yield reported by Goud Reddy et al. (1973) was 1534 kg ha^{-1}, only half the yield of the control plots in Experiment III of this study, 3110 kg ha^{-1}. We may conclude

TABLE XIII

YIELD AND SOUND MATURE KERNELS
(SMK) OF FLORUNNER PEANUTS
EXPERIMENT III, 1981

Treatment	Rate	Yield kg ha^{-1}	SMK %
Check		3110	72.3
12-4-4(A)1/	2.34 l ha^{-1}	2920	71.0
12-4-4(B)2/	4.68 l ha^{-1}	2500	71.2
10-10-10(A)	2.34 l ha^{-1}	2720	70.5
10-10-10(B)	4.68 l ha^{-1}	2670	72.2
9-18-9(A)	2.34 l ha^{-1}	2970	70.5
9-18-9(B)	4.68 l ha^{-1}	2740	72.7
3-18-18(A)	2.34 l ha^{-1}	2610	71.0
3-18-18(B)	4.68 l ha^{-1}	2540	72.5
28-0-0(A)	7.00 l ha^{-1}	2610	70.0
28-0-0(B)	14.00 l ha^{-1}	2630	71.5
9-11-7(A)	2.34 l ha^{-1}	2760	73.2
9-11-7(B)	4.68 l ha^{-1}	2980	72.2
		NS	NS

1/(A) - Recommended Label Rate
2/(B) - 2x Label Rate
NS denotes non significance at Mg = 0.05 level of probability.

from the comparison of these two studies that it is possible to obtain an increase in yield with foliar applied P on a soil that is low in P fertility. But, the yield increase will still be well below yields achieved on soils that test high in P fertility. A secondary conclusion, based upon a comparison of this study and the work of Reddy et al. (1973), is that sufficient P can not be supplied by foliar application to duplicate yields of peanuts on high P fertility soils. However, large increases in yields have been observed when sufficient P is soil applied to peanuts grown in low P fertility soils (Scarsbrook et al. (1956)).

CHAPTER V

SUMMARY AND CONCLUSIONS

The concept of applying macronutrients to crops through foliar application is indeed appealing. As stated earlier, micronutrients have long been applied in this manner and instances may exist wherein this method may prove advantageous. The results obtained from these studies indicate that foliar application of N, P, and K fertilizer sources on soils that are medium to high in fertility has not proven effective. In all studies conducted, no significant response was found to any fertilizer rate utilized, to combinations of foliar fertilizer and fungicide, to timing of foliar applications, or to rates of applications. These results are further substantiated by the work of Balwinder and Rana (1979) where low, medium, and high P soils were utilized in an experiment to determine peanut response to several soil P levels. They concluded that the response of peanuts to foliar applied nutrients is extremely limited on soils with adequate P. Further, foliar application of macronutrients does not appear to be a feasible method for increasing yield or quality of peanuts.

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VITA 2

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