EFFECTS OF WATER SOURCES AND FERTILIZERS ON PEANUT PLANTS IN THE GREENHOUSE[1]

Donald J. Banks and Billy G. Jordan

Department of Agronomy, Oklahoma State University, Stillwater, Oklahoma

Experiments were conducted using different sources of water (tap, lake, distilled, acidified tap, and acidified distilled water) and different fertilizer treatments to seek the best method of growing peanut plants under greenhouse conditions. Distilled water proved to be best; acidification of tap water was beneficial. Use of acidifying soluble fertilizers (21-7-7 and 20-20-20) in combination with distilled water, sand, and plastic pots gave good results.

We have experienced considerable difficulty from time to time in growing healthy peanut plants in our greenhouse. Early growth usually appears to be normal, but gradual deterioration in the appearance of the plants takes place shortly after blooming. The symptoms most often observed are a general yellowing of the plants, mottling of the leaves, browning of leaf margins, and lack of vigor. Inadequate fertility might have been considered to be the cause of the problem, had we not experienced similar difficulties when several fertility treatments and soil media were used. Some preliminary evidence indicated that the trouble might be caused or accentuated by the source of the water we used.

To gain further evidence as to whether or not different water sources might have an influence on peanut growth and production, the following three experiments were designed.

MATERIALS AND METHODS

Variation in water source. "Starr" variety Spanish peanut (*Arachis hypogaea* L.) seeds were planted, one per pot, in 6-inch standard clay pots on October 27, 1967, in steam-sterilized, sandy loam soil obtained from the Perkins Agronomy Farm (Table 1). Legume bacteria inoculation was not employed. Four plant replications, in a completely randomized design of the following treatments, were grown in a fiberglass greenhouse with temperatures ranging from 21 to 29 C. Treatment consisted of watering each pot daily with 250 ml of water from one of the following sources: *a*) tap (ordinary city water), pH 7.6; *b*) lake water (from Lake Carl Blackwell, the source of raw city water), pH 8.0; *c*) distilled water, pH 6.3. The pots were fertilized about mid-month in November, December, January, and February with 60 ml of a 20-20-20 soluble fertilizer solution (14.2 g of fertilizer per gallon of distilled water). Heights of the central stems, from the cotyledon to the tip of the extended upper leaflet, were measured on March 18, 1968. On the same date, an analysis of our tap water was made by the Soil Testing Service of Oklahoma State University. Soil from one replicate of each treatment was dried and analyzed by the same laboratory.

Variation in pH of water. "Argentine" variety Spanish peanut seeds were placed in a seed germinator on March 4, 1968 and, on March 11, the resulting seedlings were transplanted, one per 6-inch standard clay pot, in steam-sterilized, sandy soil obtained from the Caddo Peanut Research Station. Legume bacteria inoculation was not employed. Plants were watered with distilled water as required until March 20, when one of the following water treatments was initiated, with water added at the rate of 250 ml per pot per day: *a*) plain tap water, pH 7.4; *b*) plain distilled water, pH 6.2; *c*) acidified tap water, pH 4.5; *d*) acidified distilled water, pH 3.0. Acidifications were made with sulfuric acid, using 3 ml of 1/N H_2SO_4 per liter of tap water to adjust the pH to 4.5, and 0.8 ml of 1/N H_2SO_4 per liter of distilled water for pH 3.0. (The desired pH range of water was first deter-

[1] Based on cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma. Approved as Journal Paper No. 2144, Oklahoma Agricultural Experiment Station. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture, and does not imply its approval to the exclusion of other products that may be suitable.

mined empirically, testing it on soil samples similar to those used in the experiments and checking the resulting soil pH values.)

The plants were arranged in a completely randomized design, with four replications of each treatment, and grown in a fiberglass greenhouse at 21 to 29 C. On August 8, the plants were harvested and the following data obtained: *a*) plant heights (measured as previously described); *b*) wet plant weights; *c*) seed weights (seeds taken from mature pods that had cured at room temperature for approximately 2 weeks); *d*) soil analysis.

Combined variations of water and fertilizer. "Argentine" variety Spanish peanuts were germinated in a seed germinator at 18 to 24 C for 5 days and then transplanted, one per 7-inch plastic pot, in a steam-sterilized sand or soil medium, on March 10, 1969. Potting media were not inoculated with legume bacteria. Prior to planting, the pots were prepared as follows. The drainage holes were plugged with glass wool to retain the potting media, but to allow drainage. After filling the pots with sand or soil, they were flushed with 250 ml of tap or distilled water, depending on which was to be used in the nutrient solutions. A preparation of trace elements, Peters No. 503 (Robert B. Peters Co., Inc., Allentown, Pa.), was added in amount of 0.2 g per pot. This material was mixed into the medium at the surface and the pots were then flushed with 250 ml of full-strength Hoagland and Arnon (1) solution (type 1) in distilled water. Each of the treatments listed below was applied to three replicate plants growing in a fiberglass greenhouse at 21 to 29 C in a completely randomized design. The treatments are designated here according to identification number, potting medium, water source, fertilizer type, and strength of fertilizer solution (or amount used), in that order.

1. Sand, distilled H_2O, Hoagland and Arnon (H&A), ½.
2. Sand, tap H_2O, H&A, ½.
3. Soil, distilled H_2O, H&A, ½.
4. Soil, tap H_2O, H&A, ½.
5. Sand, distilled H_2O, Peters 20-20-20 (30% acid) (Robert B. Peters Co., Inc., Allentown, Pa.), 4.5 g per gal.
6. Sand, distilled H_2O, Peters 21-7-7 (78% acid), 4.5 g per gal.
7. Sand, distilled H_2O, Peters 10-30-20 (21% acid), 9 g per gal.
8. Sand, distilled H_2O, Mag Amp 7-40-6 (10% basic) (W. R. Grace & Co., Baltimore, Md.), 3.4 g per pot.

Each pot was fertilized with 250 ml of the respective solution, at the surface, at 6- to 7-day intervals on the average, except in the case of Treatment 8, where plants received fertilizer granules (3.4 g per pot) only at the start of the experiment. The plants were watered daily, as required, from their respective source of water, by placing the water in saucers in which the pots rested.

Two-spotted spider mites were controlled, as required, by spraying plants with Kelthane (Rohm and Haas, Philadelphia, Pa.), Morestan (Chemagro Corp., Kansas City, Mo.), or Pentac (Plant Products Corp., Blue Point, L. I., N. Y.).

The date of first bloom for each plant was recorded, as were the number of days from planting to blooming. On April 26, plant heights were measured as in the first two experiments. On June 30, the plants were harvested, their root systems were washed clean, and the following information was recorded: *a*) dry weight of whole plant (oven-dried for 6 days), and *b*)

TABLE 1. *Results of analyses of soils after different water treatments.*[a]

Water treatment	Soil pH	Pounds available per acre K	Mg	Ca	P	N (%)	Salts (ppm) Total
Tap	7.95	125	214	460	43.36	0.029	129.7
Lake	7.90	120	248	430	43.36	0.025	121.7
Distilled	6.15	95	58	340	33.93	0.021	56.8
Original soil[b]	6.60	85	141	340	30.16	0.021	114.7

[a] Values, at conclusion of experiment, for one of the plants on the treatment.

[b] Sandy loam soil from Perkins Agronomy Farm before water treatment.

umber of mature (plump) seeds per lant.

RESULTS AND DISCUSSION

ffect of variation in water source

Plants treated with distilled water had darker green color and looked healthier han plants receiving other treatments. The ifferences were quite apparent on Jan- ary 4 and continued to be so throughout he test period. On March 18, the height f plants treated with tap, lake, and dis- lled water were 9.9, 10.3, and 16.1 inches, spectively.

Results of the tap water analysis were s follows: calcium, 43 ppm; magnesium, 2 ppm; sodium, 45 ppm; chloride, 83 ppm; ılfate, 22 ppm; carbonate, 0; bicarbonate, 73 ppm; total dissolved solids, 325 ppm; H 7.9. The results of soil analyses are ıown in Table 1.

Plants treated with distilled water in- uded the tallest plants, but the differ- ıce between the mean height of these lants and those of plants on other treat- ents was not statistically significant. alues for pH and total salt content were uch higher for soil receiving tap and lake ater than for distilled water-treated soil. The data show that the changes in soil pH and its total salt content were due to the type of water used, and that these differences in soil pH and salt content were probably responsible for different plant responses. The data gave no evidence that growth differences were due to chemical pre-treatment of tap water, *i.e.*, the addition of lime, alum, chlorine, and fluoride to city water.

Effect of pH of water

Plant heights, plant weights, and seed weights, as plant responses to water of different source and pH, are presented in Table 2. Plant and seed weights were highest when the treatment was plain distilled water and poorest with plain tap water. However, no statistically significant differences could be detected between plants given acidified tap, plain distilled, or acidified distilled water. It is interesting that plain distilled water was significantly superior to plain tap water in all cases. Treatment with plain tap water gave the highest soil pH value (Table 3). Acidifying the tap water appeared to improve it in terms of plant responses, although statistical significance was attained for plant weight only. Just how acidification improved plant performance is not known,

TABLE 2. *Peanut plant responses to water of different source and pH.*[a]

Water treatment	pH of water	Plant height (cm)	Plant weight (g)	Seed weight (g)
Plain tap	7.4	27.5 y	18.3 y	1.3 y
Acidified tap	4.5	34.0xy	39.2x	3.1xy
Plain distilled	6.2	35.5x	42.8x	3.5x
Acidified distilled	3.0	39.0x	30.9xy	2.9xy

[a] Figures shown are the mean values for four replicate plants. Means not followed by a common letter (x or y) are statistically different at the 5% level, according to the Duncan Multiple Range Test.

TABLE 3. *Results of analyses of soils after treatment with water of different source and pH.*[a]

Water treatment	Water pH	Soil pH	Pounds available per acre K	Mg	Ca	P	N (%)	Total salts (ppm)
Plain tap	7.4	8.2	200	202	475	11.31	0.025	238.6
Acidified tap	4.5	6.9	170	190	375	5.66	0.036	277.4
Plain distilled	6.2	7.1	125	113	385	5.66	0.025	161.2
Acidified distilled	3.0	7.0	215	176	330	7.54	0.025	145.5
Original soil[b]		7.0	265	150	380	9.43	0.029	213.1

[a] Values are for one of the plants on the treatment at the conclusion of the experiment.

[b] Sandy soil from the Caddo County Peanut Research Station.

but it probably improved the uptake ratio of certain nutrient elements. It is well known that the availability of certain mineral elements is influenced by soil pH. Nelson (2) reported "overliming injury" in peanuts growing in a field with soil of pH 7.7, in North Carolina. Our situation may be similar to "overliming injury" because of the pH change and high calcium content.

The soil analyses results are presented in Table 3. It is noteworthy that the concentration of calcium increased in the soil treated with plain tap water.

Effect of combined variations of water and fertilizers

In this experiment, the growth of all plants appeared to be normal through April 1. By April 5, however, distinct differences in growth became apparent. Treatment 2 (sand, tap H_2O, H&A, ½) plants were shorter and a lighter green than were the other plants. Treatment 8 (sand, distilled H_2O, 7-40-6) plants had grown well, but were beginning to show yellowing and reddish-brown discoloration on some of the older (lower) leaves. Plants on other treatments showed no discoloration. Generally, plants on treatments 5 (sand, distilled H_2O, 20-20-20) and 6 (sand, distilled H_2O, 21-7-7) appeared to be significantly healthier than the other plants throughout the test period. At harvest, it was noted that plants grown in the soil media, *i.e.*, treatment 3 (soil, distilled H_2O, H&A) and treatment 4 (soil, tap H_2O, H&A), had poorly developed root systems as compared with those grown in sand. Poor aeration may have contributed to the poor root development.

The number of days from planting to first bloom ranged from 37 to 72 days. No statistically significant differences in blooming date could be attributed to treatments. The statistical data for plant heights, weights, and seed yield are presented in Table 4.

TABLE 4. *Effects of type of water and fertilizer on peanut plants.*[a]

Treatment number[b]	Height (cm)	Dry matter (g)	Number of seeds
1	30.5 y	59.7 xyz	10.7 xy
2	21.7 x	3.7 x	0.3 x
3	27.8 y	78.4 z	20.3 y
4	30.0 y	14.5 xy	8.3 xy
5	39.0 z	56.2 xyz	44.0 z
6	36.7 z	95.9 z	43.3 z
7	38.7 z	49.4 xyz	33.7 z
8	29.5 y	70.6 yz	10.3 xy
Coefficient of variability (%)	9.0	56.9	34.7

[a] Figures are the mean values for 3 replicate plants on the treatment. Means not followed by a common letter (x,y,z) are significant at the 5% level, according to the Duncan Multiple Range Test.

[b] See text for formulations.

It will be noted that the commercial fertilizer solutions (treatments 5, 6, and 7) were significantly superior to other fertilizers in their ability to produce plants that yielded the greatest number of seeds.

REFERENCES

1. D. R. HOAGLAND and D. I. ARNON, Calif. Agri. Exp. Sta. Cir. 347, 1950.
2. W. L. NELSON, in *The Peanut, The Unpredictable Legume.* National Fertilizer Association, Washington, D. C. 1951, Chapt. 5.