Reprinted from PLANT PHYSIOLOGY, Vol. 16, No. 4, pp. 834–836, 1941.

USE OF NITRIC ACID IN CONTROL OF' PH AND NITRATE LEVELS IN NUTRIENT SOLUTION

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TRELEASE AND TRELEASE (2) have called attention to the advantages, from the standpoint of pH control, of using mixtures of ammonium and nitrate salts in malting up nutrient solutions. Sulphuric acid is customarily employed as a means of adjusting the pH of solutions during au experiment. The purpose of this paper is to call attention to the advantages of using nitric acid as a means of maintaining at one and the same time both H-ion concentrations and nitrate levels. The writer has used nitric acid for this purpose over a number of years with considerable success.

TABLE I

VARIATIONS IN PH WITH THE ADDITION OF NITRIC ACID

Date		pH*	Added* Acid	Transpi-ration	Light intensity†	Evapo-ration ‡
			ml.	liters	gm. cal./sq. cm./day	ml.
Sept.	14		400	82	528	798
	15		...	109	499	960
	16	6.0		121	525	1090
	17	6.3	50	133	503	908
	18	6.2	50	89	399	832
	19	6.1		70	307	765
	20	6.2	50	82	280	1090
	21	6.1	50	105	397	1108
	22	5.9		93	364	973
	23	6.1	50	67	269	984
	24	5.9		rain	257	
	25	5.5			72	430
	26	5.7		33	304	334
	27	6.1	50	43	441	472
	28	5.9		43	435	453
	29	5.9		45	456	502
	30	6.1	500	47	415	506
Oct.	1	6.1		43	364	437
	2	5.9		54	426	504
	3	5.9		50	413	476
	4	6.1	50	54	466	568
	5	5.7		52	450	563
	6	5.9		30	257	221

* pH readings and acid additions were made at 8:00 A.M. and 9:00 A.M. respectively.
† Eppley pyrheliometer, University of California, Citrus Experiment Station.
‡ Circular shallow pan evaporimeter, 0.1 sq. meter.

The extent to which nitrate levels can be maintained by periodically adjusting the pH to some selected level with nitric acid is contingent upon the kind of plant, its stage and condition of growth, and climatic factors (particularly light intensities) and the selected pH. The writer's work has been entirely in the Southwest where bright days and upward trends in pH are the rule. All of the cultures have been carried at a pH of about 6.0.

For the purpose of illustration, an example is taken from 1939 experiments wherein plants were grown in large out-of-doors sand cultures (1, fig. 4) in salt toxicity studies. These sand beds were supporting 30-inch rows each of milo, cotton, squash (harvested September 18), alfalfa, sugar beets, cowpeas, and tomatoes planted in mid July. The volume of the solution reservoirs was 2400 liters with an additional 300 liters retained in the sand, thus permitting the addition of reatlily measurable amounts of concentrated nitric acid. In this system, 50 ml. of nitric acid (sp. gr. 1.42) introduces 0.27 m.e. of NO, ion per liter. Using tap water to replace transpiration losses, new solutions starting with 7.5 to 8.0 m.e. per liter of NO, ion at pH 6 typically contain from 7 to 9 m.e. at the time the solutions arc discarded. Similar effects have been observed in the parallel experiments conducted under cool coastal conditions near San Diego, under the desert conditions of

TABLE II

ANALYSES OF' NEW AND OLD SOLUTIONS AND OF TAP WATER ADDED TO REPLACE TRANSPIRATION AND EVAPORATION LOSSES

SOLUTIONS ANALYZED	PERIOD SEPTEMBER 15 TO OCTOBER 7 (SEE TABLE I) MILLIEQUIVALENTS PER LITER							
	Ca	Mg	Na	K	HCO_3	SO_4	Cl	NO_3
New solution	4.90	3.80	1.96	1.66	0.38	4.28	1.72	7.42
Old solution	5.81	3.60	2.69	0.50	0.35	4.71	1.60	7.44
Tap water	1.84	0.56	1.60	....	2.90	0.61	0.60	0.05

the Coachella Valley, and under the intermediate climatic conditions represented at Riverside. The period represented in table I was taken from the Riverside data because it illustrates the increased H-ion concentrations of the solution during a period of low light intensity during which absorption of cations exceeded that of anions. Additions of phosphate and potassium are necessary during any extended use of a solution. Table 2 reports analyses of the new and used solution and of the tap water used in making up and replenishing solutions. Five m.e. of nitrate were added as calcium and potassium salts in making up this solution and then sufficient HNO, was added to bring the pH down to 6.0. Results comparable with the foregoing have been obtained in the beds receiving toxic concentrations of chloride and sulphate salts and also in small greenhouse sand cultures supporting single species of plants.

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LITERATURE CITED

1. EATON, FRANK M. Plant culture equipment. Plant Physiol. **16: 385-392. 1941.**

2. TRELEASE, **S.** F., and THELEASE, **II. M.** Physiologically balanced culture solutions with stable hydrogen-ion concentration. Science n.s. **78 : 438439. 1933.**