Texas and the University of Chicago, President Hutchins and the Board of Trustees of the University of Chicago have decided to strengthen the department of astronomy and astrophysics by the appointment of several new members. Dr. G. P. Kuiper, formerly of the University of Leiden and of the Lick Observatory, joined the staff at Williams Bay on September 1. Dr. Kuiper is known for his studies of double stars and for the discovery of several "white dwarfs." He expects to start, after January 1, a series of observations of double stars with the 12-inch telescope of the Yerkes Observatory, which is now temporarily mounted in Texas. Dr. B. Strömgren, formerly of the University of Copenhagen, began, on October 1, a course of lectures on astrophysics at the University of Chicago. Dr. Strömgren is interested, among other things, in the interpretation of the Russell-Hertzsprung diagram; he plans to spend a part of his time in Williams Bay. Dr. S. Chandrasekhar, of Madras, India, and more recently of Cambridge University and Harvard, will commence work at the Yerkes Observatory on January 1, 1937. Dr. P. C. Keenan, who has rejoined the Yerkes staff after a year's absence, will cooperate with Dr. W. W. Morgan in a study of the luminosities and physical characteristics of the stars. It is expected that the old, as well as most of the new, members of the staff will make periodic trips to Mount Locke to secure observational material with the large reflector.

OTTO STRUVE

YERKES OBSERVATORY
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SPECIAL ARTICLES

MATHEMATICAL EXPRESSION OF EQUILIBRIUM BETWEEN NITROGEN AND PHOSPHORIC ACID IN PLANTS

IT has been known for nearly half a century that phospholipins (phosphatides) found in all cells play a predominant rôle in the physiological processes involved in growth and reproduction. In some plant species phospholipins were found to vary directly with the protein-N and in others with the amide-N.[1]

With the growth of conviction among biologists that the final truth of a phenomenon lies in the mathematical description of it, mathematical expressions for the physiological relationships between the various elements ("entities") and plant response to them have been sought,[2] expressible in terms of simple laws.[3]

In investigations now under way in this laboratory on the influence of the soil and the weather on the action of fertilizers by means of periodic analysis of leaves of the same metabolic age (foliar diagnosis) certain plots of Tier 1, Section B, of the long-continued vegetable fertility plots of the Department of Horticulture, on which potatoes were growing in 1935, have been examined. Plot 15, which has received partly rotted horse manure at the rate of thirty tons per acre, has continuously given the highest yields on this particular tier. In 1935 the yield of tubers was 196 pounds per 1/100th acre plot. The plants growing on this plot, therefore, may be regarded as well nourished and nearing the optimum for the soil and climatic conditions in this region.

In Fig. 1 are plotted as ordinates and abscissae,

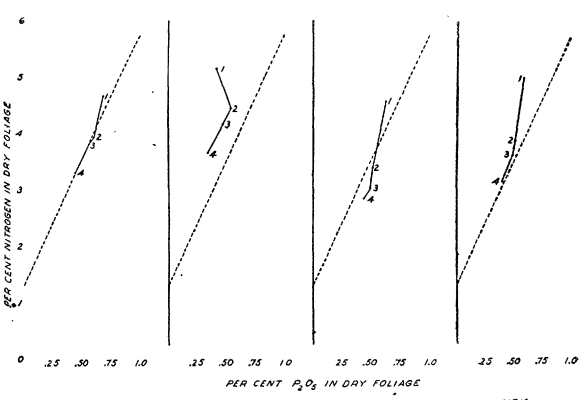

FIG. 1. Showing the deviations from the optimum physiological balance between nitrogen and phosphoric acid in four differently treated plots.

respectively, the data for the chemical analysis for total nitrogen (N) and total phosphoric acid (P_2O_5) of the fourth and fifth leaves taken from plants growing on this manure plot (Plot No. 15) and also from three plots treated with commercial fertilizers; namely, nitrogen alone (Plot No. 2), phosphate + potash (Plot No. 8) and nitrogen + phosphate + potash (Plot No. 10). The numerals 1, 2, 3, 4 indicate, respectively, the coordinate points for each of the sampling dates—July 7, July 29, August 9 and August 24, 1935.

The broken line has been drawn by joining the coordinates (given in columns 1 and 2, Table 1) for the third and fourth samplings, taken on August 9 and August 24, respectively, of leaves of the same physiological age of plants growing on the manure plot. The scale for P_2O_5 is twice that for N. *The equation to this line is* $y = 2.2x + 1.31$. The ordinates of this line corresponding to the amounts of P_2O_5

[1] F. Czapek, "Biochemie der Pflanzen," Zweite Auf, pp. 772–773, Jena, 1913.
[2] Walter Thomas, SCIENCE, 70: 382–384, 1929.
[3] H. Lagatu and L. Maume, *Compt. Rend.*, 180: 1179, 1925.

found by analysis at successive sampling dates vary very little from the amounts of N found experimentally. The deviation of experimental values calculated from the above equation is shown in the last column of Table 1.

TABLE 1

EXPERIMENTAL VALUES FOR P_2O_5 AND EXPERIMENTAL AND CALCULATED VALUES FOR N IN DRY FOLIAGE AT FOUR SAMPLING DATES FOR PLANTS GROWING ON THE MANURE PLOT

Dates of sampling	Experimental values		Calculated values	Relative deviation
	P_2O_5 (E_x)	N (E_y)	N (E_{y_1})	$\frac{E_y - E_{y_1}}{E_y}$
	Per cent.	Per cent.	Per cent.	Per cent.
July 7 ...	0.688	4.650	4.340	+ 0.067
July 29 ...	0.608	3.920	3.980	− 0.015
Aug. 9 ...	0.564	3.790	3.790	0
Aug. 24 ...	0.448	3.280	3.280	0

On the first sampling date (July 7), nitrogen in this manure plot is somewhat in excess in relation to the optimum value; a result which can be accounted for by an excess absorption of nitrogen caused by the intervention of nitrogen produced by nitrification in a favorable season from the cover crops used in the rotational system. On the second (July 29), third (August 9) and fourth (August 24) sampling dates equilibrium between N and P_2O_5 is attained.

The yields of tubers from the three other plots are: N (Plot No. 2) 109 pounds, PK (Plot No. 8) 148 pounds and NPK (Plot No. 10) 163 pounds per 1/100th acre plot. The deviation from the optimum (broken) line with respect to position, form and length between sampling dates shows in each case the nature of the disequilibrium between N and P_2O_5 in the plants growing on the particular plot and may be regarded as an indicator of the lack of physiological balance between nitrogen and phosphorus. Details will be published elsewhere.

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RAMAN SPECTRA OF AMINES AND METHYLATED AMMONIUM IONS

FROM the point of view of the electronic theory of valence, the ammonium ion is an exact analogue of methane, the methylammonium ion of ethane, the tetramethylammonium ion of tetramethyl methane, and so forth. Thus two systems of analogous compounds exist. Since ammonium ions can exist only in association with a suitable anion as salts, most of the physical properties of the latter are very different from those of the analogous hydrocarbons. Study of Raman spectra, however, reveals directly the intimate relation between the two series of compounds, for the spectra of the substituted ammonium halides are produced only by the vibrating cations, the isolated halide ions containing no covalent bonds and therefore giving rise to none of the observed vibrations. It should thus be expected, and has been experimentally found, that the spectra of the ammonium chlorides, from the monomethyl to the tetramethyl derivative, are completely analogous to those of the corresponding hydrocarbons from ethane to tetramethyl methane, which have been studied by other investigators.[1, 2, 3] If CH_3 and $^+NH_3$ groups be regarded approximately as single vibrating units, then these compounds possess certain well-known types of symmetry and should give rise to a few simple fundamental vibrations. The methyl ammonium ion, for instance, behaves similarly to a diatomic molecule and gives rise to a powerful valence vibration involving the C–N^+ bond. The observed fundamental vibrations (which lie in the region below 1,050 cm^{-1}) are as follows (the assumed geometrical pattern of each ion is given in parentheses, following its designation):

Methylammonium chloride (linear "diatomic" ion): 995 (6). (Compare ethane.)

Dimethylammonium chloride (symmetrical bent "triatomic" ion): 412 (2) (P); 895 (4) (P); 1029 (2) (D). (Compare propane.)

Ethylammonium chloride (unsymmetrical bent "triatomic" ion): 411 (2); 873 (5); 1047 (4). (Compare propane.)

Trimethylammonium chloride (Trigonal pyramid): 406 (1) (D); 468 (1/2) (P); 821 (5) (P); 987 (4) (D). (Compare isobutane.)

Tetramethylammonium chloride (regular tetrahedron): 372 (1) (D); 455 (2) (D); 752 (6) (P); 955 (6) (D). (Compare tetramethyl methane.)

Trimethylamine oxide hydrochloride (Trigonal pyramid): 382 (3); 500 (2); 754 (7); 947 (7). (Compare tert-butyl alcohol.)

The number in parentheses following the frequency of each line indicates its roughly estimated relative intensity. Some qualitative polarization measurements have also been made; P denotes a strongly polarized line, ($\varrho << 6/7$), D a nearly depolarized line ($\varrho = 6/7$). Analysis of the observed spectra indicates that they are in harmony with expectations from the structures assumed, and comparison with the corresponding hydrocarbons indicates that the C–N^+ bond is somewhat stronger than the C–C bond.

These compounds of course yield numerous Raman frequencies above 1,050 cm^{-1}, owing to the presence of numerous C–H and $^+$N–H bonds. The free amines

[1] K. W. F. Kohlrausch and F. Köppl, *Zeits. physik. Chem.* (*B*), 26: 209, 1934.
[2] D. H. Rank, *Jour. Chem. Physics*, 1: 572, 1933.
[3] R. Ananthakrishnan, *Proc. Indian Acad. Sci.* (Bangalore), 3(A): 527, 1936.