accelerates, and then retards reaction, the final phase setting in the earlier the higher the nitrous acid concentration. For fixed concentrations of nitric acid, an increasing concentration of nitrous acid at first strongly accelerates, then retards, and then weakly accelerates nitration, the retardation setting in the earlier the higher the concentration of nitric acid. These statements apply to the general conditions investigated, in which the concentration of nitrous acid was shown to remain constant during nitration.

The detailed presentation and analysis of these relations would be lengthy; but we may state our conclusions. They are, first, that nitric acid is doing three things: it is producing a strong nitrating agent (NO_2+); it is converting the aromatic compound into a nitration-resisting oxonium ion; and it is helping nitrous acid to suppress NO_2+ (by converting N_2O_4 into ions, in particular nitrate ion, as described in the first of these communications*). Secondly, nitrous acid is also doing three things: it is uniting with the phenol derivative to form a complex, which is highly reactive in nitration; it is, as already mentioned, co-operating with nitric acid to produce nitrate ion and thus to suppress NO_2+; and, in the form N_2O_4 (or $2NO_2$), it is itself acting as a direct nitrating agent.

We think the complex may depend on univalent electron exchange[1]. Veibel[2] has already postulated an addition complex between phenol and nitrous acid. Arnall[3] has previously assumed direct nitration by N_2O_4.

With phenols, especially in aqueous solvents containing much nitrous acid, yet another mechanism enters, which has been considered before[2,4], namely, nitrosation with subsequent oxidation. Our main evidence of this is that whereas phenol on nitration in water in the presence of as little nitrous acid as possible (PhOH = 1, HNO_3 = 1, HNO_2 = 0 mol.) yields *o*- and *p*-nitrophenols in the approximate proportions 7 : 3, in the presence of a large amount of nitrous acid (for example, PhOH = 1, HNO_3 = 1, HNO_2 = 2 mol.) the ratio becomes changed to 1 : 9, and this is the ratio in which *o*- and *p*-nitrosophenols are formed if the nitric acid is omitted[2]. *p*-Nitrosophenol has been isolated as a by-product from the latter nitrations.

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Organic Nitrogen Compounds as Nitrogen Nutrition for Higher Plants

In sterile cultures pea and clover use especially well aspartic and glutamic acids for their nitrogen nutrition, as demonstrated by previous experiments in this laboratory[1]. Both the optical forms are utilized[2]. If the nutrient solution contains aspartic acid as well as nitrate and ammonium sulphate, all these nitrogen sources are utilized simultaneously (see accompanying table). Aspartic acid thus competes with nitrate and ammonium nitrogens as a nitrogen source for peas, an important fact to be borne in mind when discussing the ability of plants to utilize organic nitrogen in natural conditions. Nitrogen nutrition has a marked effect on the structure of pea roots. Peas grown on nitrate nitrogen and without nitrogen form in this respect a special group; peas grown on aspartic acid nitrogen, on ammonium nitrogen and on nitrogen supplied by root nodules another.

Furthermore, we have confirmed the earlier observations that when the pea uses aspartic acid for its nitrogen nutrition, nitrogen and carbon disappear from the solution in the same proportion[3] and that no essential change occurs in the *p*H of the solution and no ammonia can be detected in the nutrient solution. In aspartic acid the ratio of carbon to nitrogen is 3·43; in the nutrient solution which originally contained 50 mgm. aspartic acid nitrogen and at the end of the experiment 16·6 mgm. nitrogen (all the remaining nitrogen being amino nitrogen) the amount of organic carbon was 57·8 mgm.; accordingly the ratio C/N = 3·48. The position was the same, when the nutrient solution contained besides aspartic acid also nitrate. The ratio of C to NH_2–N in the nutrient solution was thereby likewise 3·48. The results confirm the previous investigations of this laboratory which were interpreted by assuming that the whole aspartic acid molecule is being utilized. Not until it reaches the root cells does the transformation of aspartic acid take place (through deamination, transamination, etc.).

With plants of the family Gramineæ (wheat and barley as test plants) aspartic and glutamic acids do not function as N-source according to the previous findings of this laboratory[1]. The entirely different behaviour of legumes and non-legumes towards amino dicarbonic acids is especially noteworthy since certain other amino-acids, for example, α-alanine and glycocol, are utilizable also by wheat and barley. In our new experiments, very similar results have been obtained as in the previous ones. In one experiment the wheat grown in different nitrogen nutrition media contained the following amounts of nitrogen: without nitrogen nutrition 3·2 mgm., on aspartic acid 2·9 mgm., on glutamic acid 3·3 mgm., on nitrate 22·2 mgm., on glycocol 10·5 mgm., on α-alanine 6·8 mgm., on cystine 7·6 mgm. The amount of nutrient solution was in all experiments 20 mgm. per plant. Some other amino-acids were taken up in certain degree, but in spite of that no growth occurred which would have resulted in the rise of dry matter yield. Aspartic and glutamic acids which in some experiments were taken up in very small amounts, 1–2 mgm. nitrogen per plant, lower appreciably the dry weight of plants. Evidently they accelerate respiration. Since the transamination takes place in Gramineæ as easily as in leguminous plants (our results in this respect are in good agreement with those of Cedrangolo and Carandante[4]), the ineffectiveness of aspartic and glutamic acids is difficult to explain.

Moreover, it has been noted that if the wheat is given in sterile nutrient solution besides aspartic acid also nitrate and ammonium sulphate (each providing 22 mgm. nitrogen, total nitrogen supply per plant 66 mgm.) the wheat does not grow. The cause for this is being investigated.

Regarding the utilization of amino-acids other than aminodicarbonic acids by leguminous plants it may be mentioned that the utilization of glycocol by pea is noticeably good. α-Alanine is utilized to a certain extent, but it often causes a curious branching and shortening of internodes. The growth of pea is comparatively good on hydrolysed casein (HN_2 removed) and Witte pepton.

In the light of our laboratory experiments, especially the new ones regarding the favourable competition of some amino-acids with nitrate and ammonia nitrogen, it seems probable to us that in natural conditions plants use also organic nitrogen compounds for their nitrogen nutrition, at least in certain soils. As a rule, however, the uptake of organic nitrogen by cultivated plants is not great, since ammonium salts and nitrates are rapidly formed from organic nitrogen compounds in soil. Since, however, the uptake of organic nitrogen compounds even in small amounts may affect the plants markedly, the significance of these nitrogen compounds can be great. In the foregoing, alanine has been noted to cause pronounced changes in the shape of pea, and phenyl ethylamine, the decarboxylation product of phenylalanine, which has been added to nitrate-containing nutrient solution, has produced a branching of different type in pea. Effects of this kind can be expected to occur under certain conditions also in Nature.

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Botanical Origin of Tube-Curare

dextro-Tubocurarine chloride was first isolated in crystalline form from native tube-curare[1]. It has since become a valuable adjunct in anæsthesia[2]. The chemical constitution of *dextro*-tubocurarine chloride and its relation to bebeerine[3] suggests that its botanical origin lies in some species of *Chondrodendron*. Through the kindness of Mr. J. W. Massey, British consul in Iquitos, the stem and leaves of *Chondrodendron tomentosum* Ruiz and Pavon, collected by the late Guillermo Klug at Tarapoto in Peru, have been made available. The leaves were identified by Mr. N. Y. Sandwith of the Herbarium, Kew, as belonging to this species, and on chemical examination the stems yielded *lævo*-curine (*l*-bebeerine) and *lævo*-tubocurarine chloride. The latter was found by Dr. B. D. Burns to have a curare action on the rat's diaphragm, which was very weak when compared with that of *dextro*-tubocurarine chloride.

On the other hand, Dutcher[4] has examined a native Upper Amazonian curare prepared from *Ch. tomentosum* and has isolated *dextro*-tubo-

Torsdag-pea grown on different N-nutrition in sterile water cultures. One plant in each flask containing 1 l. nutrient solution. Sterile plants were transferred to culture flasks January 19–21, 1946.

Quality of N-nutrition Amount of N-nutrition, N (mgm.)	$(NH_4)_2SO_4$ + $Ca(NO_3)_2$ + Aspartic acid 50 + 50 + 50 = 150				$Ca(NO_3)_2$ + Aspartic acid 50 + 50 = 100				$(NH_4)_2SO_4$ + Aspartic acid 50 + 50 = 100	
Number of days N-nutrition given	14	22	28	35	14	22	28	35	22	38
Dry weight of plant (mgm.)	919	1789	2589	2987	857	1989	1823	2792	487	688
N in plant (mgm.)	48·3	86·6	108·7	118·9	38·9	61·2	49·8	64·3	27·9	42·4
N in % of dry matter	5·2	4·9	4·0	4·0	4·5	3·1	2·7	2·3	5·7	6·2
Final *p*H of the nutrient soln.	6·1	6·1	6·5	6·8	6·9	6·9	7·5	7·4	6·3	6·0
NO_3—N used (mgm.)	10·8	23·1	25·8	26·0	19·6	33·1	26·2	37·4		
NO_3—N in % of total N used	22·8	28·6	24·2	22·4	55·7	61·1	54·8	63·7		
NH_4—N used (mgm.)	16·5	31·5	40·8	49·0					13·6	21·2
NH_4—N in % of total N used	34·9	39·1	38·2	42·1					69·4	53·1
NH_2—N used (mgm.)	20·0	26·0	40·0	41·3	15·6	21·1	21·5	21·3	6·0	18·7
NH_2—N in % of total N used	42·3	32·3	37·6	35·5	44·3	38·9	45·2	36·3	30·6	46·9
Total used N (mgm.)	47·3	80·6	106·6	116·3	35·2	54·2	47·7	58·7	19·6	39·9