ART. V.—Contributions from the Sheffield Laboratory of Yale College. No. IX.—On the assimilation of complex nitrogenous bodies by Vegetation ; by S. W. JOHNSON.

DURING the summer of 1861 the writer undertook a series of observations on the nutrition of plants, which, though a failure as regards the principal object of the investigation, led to some interesting results. Besides various inorganic matters, the nitrogenous compounds occurring in urine which may be directly applied to crops as fertilizers, viz: urea, guanine, uric acid and hippuric acid, were intended to be made the subjects of experiment.

Washed and ignited flower-pots (of clay, unglazed) were employed to contain, for each trial, a soil consisting of 700 grms. of ignited and washed granitic sand mixed with 0.25 grm. sulphate of lime, 2 grm. ashes of hay prepared in muffle and 2.75 grm. bone-ashes. This soil was placed upon 100 grms. of clean gravel to serve as drainage.

In each of several pots containing the above soil was deposited July 6th, a weighed kernel of maize. The pots were watered with equal quantities of distilled water containing a scarcely appreciable trace of ammonia. But four seeds germinated in a healthy manner, the plants developed slowly and alike until July 28th, when the addition of nitrogenous matters was begun.

To No. 1, no solid addition was made.

To No. 2, was added July 28, 0.420 grm. uric acid.

To No. 3, was added 1.790 grm. hippuric acid, at four different times, viz: July 28, 0.358 grm., Aug. 26th, 0.358 grm., Sept. 16th, 0.716 grm., Oct. 3d, 0.358 grm.

To No. 4, was added 0.4110 grms. hydrochlorate of guanine,

viz: July 28th, 0·0822 grm., Aug. 26th, 0·0822 grm., Sept. 16th, 0·1644 grm., Oct. 3d, 0·0822 grm.

The nitrogenous additions contained in each case, 140 grm. of nitrogen, and were strown, as fine powder, over the surface of the soil.

It not being practicable to attend to the germination of other seeds, urea was not experimented with. This deficiency was of less account, since Cameron's paper on the direct nutritive effect of urea, read before the British Association in 1857, had demonstrated that this substance supplies the plant with nitrogen without previous decomposition in the soil and has a fertilizing effect equal to salts of ammonia.

The plants continued to grow or to remain healthy, (the lower leaves withering more or less,) until they were removed from the soil Nov. 8th.

The plants exhibited striking differences in their development. No. 1, (no added nitrogen) produced in all seven slender leaves and attained a height of seven inches. At the close of the experiment, only the two newest leaves were perfectly fresh, the next was withered and dead throughout one-third of its length. The newer portions of this plant grew chiefly at the expense of the older parts. No sign of floral organs appeared.

No. 2, fed with uric acid, was the best developed plant of the series. At the conclusion of the experiment it bore ten vigorous leaves, six of which were fresh and two but partly withered. It was 14 inches high and carried two rudimentary ears (pistillate flowers), from the upper one of which hung tassels six inches long.

No. 3, supplied with hippuric acid, bore eight leaves, four of which were withered, and two rudimentary ears, one of which was tasseled. Height 12 inches.

No. 4, with hydrochlorate of guanine, had six leaves, only one withered, and two ears, one of which was tasseled. Height 12 inches.

These experiments, together with a large number of others simultaneously undertaken, failed to give satisfactory results from the unfavorable situation of the only apartment at disposition for conducting them in. The light was good but for a small part of the day, and very unequally distributed at that. For this reason, chiefly, most of the plants made but imperfect growth and therefore the laborious analyses which would have properly supplemented the observations on growth were not attempted.

¹ This result has been recently confirmed by Hampe of Göttingen who has made maize to grow as a water-plant with its roots in a dilute solution containing sulphate of magnesia, chlorid of calcium, phosphate of potash, sesquichlorid of iron and urea. Hampe found in the well developed plants—stems and leaves as well as roots—evident quantities of urea.

In the case of the four experiments under notice, the weight of the crops (dried at 212° F.), exclusive of the fine rootlets that could not be removed from the soil, was ascertained with the subjoined results.

No. 1, (no added nitrogen,)	Weight of dried crop,	0.1935 grm.
	" " " seed,	0.1644 "
	gain,	0.0291 "
No. 2, (added 0.420 grm. uric acid,)	Weight of dried crop,	1.9470 grm.
	" " " seed,	0.1725 "
	gain,	1.7745 "
No. 3, (added 1.790 grm. hippuric acid,)	Weight of dried crop,	1.0149 grm.
	" " " seed,	0.1752 "
	gain,	0.8397 "
No. 4, (added 0.411 grm. hydro- chlorate of guanine,)	Weight of dried crop,	0.9820 grm.
	" " " seed,	0.1698 "
	gain,	0.8122 "

We thus have proof that all the substances employed contributed nitrogen to the growing plant. This is conclusively shown by the fact that the development of pistillate organs, which are especially rich in nitrogen, occurred in the three plants fed with nitrogenous compounds, but was totally wanting in the other. The relation of matter new-organized by growth to that derived from the seed is strikingly seen from a comparison of the ratios of the weight of the seed to the increase of organized matter, the former being taken as unity.

The ratio is approximatively

for No. 1,	1 : 0.2
" " 2,	1 : 10.2
" " 3,	1 : 4.8
" " 4,	1 : 4.8

The relative gain by growth, that of No. 1, assumed as unity,

is	for No. 1,	1
	" " 2,	56
	" " 3,	26
	" " 4,	26

No examination was made of the soil to ascertain whether the uric acid, &c., had undergone decomposition with formation of ammonia before entering the plant. If urea escapes decomposition, as Cameron and Hampe have shown is true, for the most part, it is not to be anticipated that the more stable bodies employed in these trials should suffer such alteration.

It will be noticed that the gain of dry matter during growth was identical in case of the plants fed with guanine and hippuric acid, and this quantity was again, quite nearly half that mani-

fed by the plant which was supplied with uric acid. Whether this is more than accidental is worthy of study.

From these experiments the writer concludes that the amids resulting from the disorganization of protein compounds, as well as ammonia salts and nitrates, are capable of direct passage into the plant, and there serve for the reorganization of albumen, &c.

Cameron, in the investigation alluded to, remarked that his results demonstrate that it is not necessary that urea should decompose into carbonate of ammonia in order to become available to vegetation, and the above facts warrant the generalization that all the amids existing in the urine of animals are ready for assimilation, without any further resolution by decay. So far as they are directly concerned, then, any "fermenting" of manures of which they are ingredients is useless.

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