of experimental error, yet should not be so large as to cause the results to lie far out on the nearly horizontal portion of the yield curve. These quantities are best determined by preliminary tests with the growth factors in question.

The four observation equations which, by proper substitution in (4), these four experimental plots give are

$$\text{Plot 1. } y_1 = A(1-R_1^{n+a})(1-R_2^{p})(1-R_3^{k}) \quad (5)$$
$$\text{" 2. } y_2 = A(1-R_1^{n})(1-R_2^{p+b})(1-R_3^{k}) \quad (6)$$
$$\text{" 3. } y_2 = A(1-R_1^{n})(1-R_2^{p})(1-R_3^{k+c}) \quad (7)$$
$$\text{" 4. } y_4 = A(1-R_1^{n})(1-R_2^{p})(1-R_3^{k}) \quad (8)$$

Dividing (5) by (8)

$$\frac{y_1}{y_4} = \frac{1-R_1^{n+a}}{1-R_1^{n}}$$

From this equation the value of n is easily found.

In a similar manner the values of p and k are found. The value of A is then found by substitution of the known values of n, p and k in (8). Equation (4) is then available for calculating the yield to be expected from any amounts of nitrogen, phosphoric acid and potash applied as fertilizers.

This matter will be presented in detail in a paper soon to be offered for publication.

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THE EFFECT OF UNILATERAL SECTION OF THE MIDBRAIN UPON COSTAL MOVEMENTS OF RESPIRATION

I WISH to add to an earlier statement[1] some recent results of unilateral section of the midbrain combined with unilateral division of the dorsal roots of the thoracic spinal nerves.

Cats were used throughout the experiments. Respiratory movements were recorded by tambours attached to Crile stethographs. One stethograph placed well up on the chest measured costal movements; the other, at the level of the diaphragm, measured diaphragmatic movements.

Experimental procedures and results were as follows: (1) Section of the dorsal roots of the spinal nerves in the thoracic region of one side, followed by section behind the inferior colliculus of the opposite side. (2) Section behind the inferior colliculus of one side, followed by section of the dorsal roots of the spinal nerves of the opposite side. (3) Section of the dorsal roots of one side, and of the inferior colliculus of the *same* side.

(1) Unilateral section of the dorsal spinal nerve roots in the thoracic region produced some slowing of the respiratory rate and some diminution in amplitude of the costal respiration, but neither of these changes was as marked as when the dorsal roots of both sides were divided. Complete cessation of the costal movements was observed on the side on which section of the dorsal roots had been done. The movements of the other side were unchanged, but naturally the amplitude recorded was not as great as normal.

In doing unilateral section of the midbrain behind the inferior colliculus, the skull was trephined over the tentorium, and, guided by the tentorium, a knife was slid perpendicularly down its caudal surface, cutting the midbrain just below the inferior colliculus. Hemorrhage was controlled by means of bone wax. The extent and location of the lesion were determined at autopsy. The result of unilateral section was to slow somewhat the respiratory rate and, in some cases, to diminish costal respiration, particularly on the side of the lesion. Diaphragmatic respiration was adequately maintained at all times. Unilateral section of the midbrain below the inferior colliculus, then, appears not to interfere greatly with the respiratory rhythm.

When, however, section behind one inferior colliculus is followed by section of the dorsal roots of the thoracic nerves *on the opposite side,* costal respiration of both sides disappears, such slight excursions of the tambour lever as are shown being induced by the diaphragmatic contractions.

(2) When the procedures are reversed, the same result is obtained as in the preceding series. True costal respiration disappears.

(3) When both operations are done on the same side, costal respiration on that side only disappears.

These results appear to show that: (1) The central station in the midbrain for afferent respiratory impulses from the dorsal roots of the spinal nerves is ipsilateral. (2) Costal respiration only is affected by section of the dorsal spinal nerve roots, or by section behind the inferior colliculus.

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[1] F. H. Pike and H. C. Coombs, SCIENCE, 56: 691–692, 1922, and the papers there cited.

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