results in the primary application of these tests. No such conflict has been observed in a large series of comparative tests.

The question of the exact immune status of these individuals presents itself, with the problem of the explanation of the mechanism involved in the suppression of the necrosing action of toxin in the absence of demonstrable antitoxin. This will involve the almost impossible task of following a large number of persons under conditions of natural exposure to infection.

Closely related to this problem is the question of the origin of antitoxin, latent immunity, local tissue immunity, etc.

[1] Kellogg, W. H., *J. Am. Med. Assn.*, 1922, lxxviii, 1782; *Ibid.*, 1923, lxxx, 748.

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Physiological Phenomena at the Time of Flowering.

H. L. VAN DE SANDE-BAKHUYZEN. (Introduced by C. L. Alsberg.)

From the Food Research Institute and the Department of Botany of Stanford University, Stanford University, Calif.

In order to study the growth curve of wheat, and especially the physiological phenomena at the time of flowering, Hard Federation wheat was grown in sand cultures under constant conditions. The illumination was continuous (Mazda C lamps), the temperature varied 1 to 2° C., the relative humidity of the air varied about 10 per cent, the water and salt content in the sand was kept as constant as possible. Every two days 6 plants were harvested and the fresh-weight and dry-weight of every leaf, stem and ear was determined in every plant separately. Each plant had 5 leaves and 1 stem with ear at maturity (all the tillers were removed as soon as they started to grow). These experiments quite confirmed the results which Kreusler[1] obtained with corn some fifty years ago. He found that the gain in dry-weight was minimum at the time of fertilization of the ears or the first development of the kernels. However, recalculation of his results and of the data of several other investigators shows a close correlation between the time when this minimum occurred and the time when 100 per cent female inflorescences were present, *i. e.,* the week during which the maximum number of female inflorescences flower. In our experiment with wheat the minimum occurred exactly at the time of stamination.

This recalculation shows, furthermore, that coinciding with the minimum gain in dry-weight, there was also a minimum gain in fresh-weight or water (fresh-weight minus dry-weight). This minimum is not due to the fact that less dry-weight was gained during that period because the gain of water per gram dry-weight gained, (gain water)/(gain dry-weight), also showed a marked minimum. The gain in water is, therefore, affected more than the gain in dry-weight, so that the relative water-content of the plant decreases suddenly. Whether there is an absolute loss of water or only a relative one, depends merely on the question whether or not the water held in the new tissue formed balances the loss of water in the plant as a whole, *i. e.,* it depends on the absolute gain in dry-weight during that time. In our experiment there was a considerable absolute loss of water exactly at the time of stamination.

Kreusler explains the minimum of increase in dry-weight by the assumption that the increased respiration at the time of fertilization destroys a large quantity of the organic matter gained by photosynthesis, this being normal during this period, so that the net gain is subnormal. This assumption, however, does not take into account the loss of water in the plant at this time. This loss of water occurs in the leaves, the stems, ears and roots. Now several investigators[2] have found that a decrease in water-content of leaves lessens photosynthesis. Therefore, the loss of water in the leaves must be one of the main causes of the minimum gain in dry-weight. The fact that the roots show a minimum as well, proves that the absence of a growing point is not the only cause of the phenomenon.

Under field conditions certain other phenomena occurring at this period come into play. As a result of the decrease in water-content the lower leaves begin to die off, so that at this time the total leaf-area begins to decrease. The gain in dry-weight per unit leaf-area ($cm.^2$), or, per gram leaf dry-weight, is, however, minimum at the time of flowering as well, proof that the minimum of total gain in dry-weight is not caused by this decrease in leaf-area.

After the time of flowering, which we may call a critical period in the life cycle, the relative water-content of the plant decreases continuously, and the leaves gradually die off from the base towards the top of the plant, so that finally the plant dies. The external meteorological conditions at the critical period must, therefore, largely affect the velocity with which the plant will dry out. We may expect, therefore, a favorable effect of cool and cloudy weather (lessening transpiration) upon the length of the period between flowering and ripening and also upon the final yield. This is exactly what meteorological statisticians[3] have claimed for several plants, such as corn, etc. J. W. Smith found that the correlation coefficient between rain fall and corn yield was maximum 10 days after blossoming (+0.74 ±0.05).

The primary cause of the death of an annual which has flowered, is thus the considerable loss of water at the time of flowering, which results in a decrease of assimilatory capacity of the leaves and their gradual dying.

A study of the literature also shows that in other plants, such as potatoes, white mustard, barley, etc., not only can a minimum of increase in dry-weight at the critical period be observed (as pointed out by Kreusler), but also a loss of water. In sugar beets, however, the relative water content of the leaves remains about constant throughout the first year; in the second year the same phenomena occur as in the first year in annuals.

Briggs, Kidd and West,[4] in analyzing Kreusler's results, claimed that at the time of the earliest stages of flower development a decrease in relative growth rate (followed by an increase) occurred, possibly due to increased respiration during this time. We cannot agree with their results, because:

1. They calculated the relative growth rate in a way which leads to erroneous conclusions, as pointed out by Fisher.[5]
2. They assumed that the critical period happened at the time of the first appearance of the inflorescences. This, however, is long before flowering.
3. The increase of the relative growth rate, which follows the decrease, as found by these authors, can be explained by high temperature at this time.

The relative growth rate is not the expression of a simple physiological phenomenon, but the product of two independent variables: (a) the assimilatory capacity per cm.^{2} leaf-area (productivity); (b) the quotient of leaf-area and total dry-weight of the plant, which we propose to call structural efficiency. The study of the relative growth rate as a product of these two variables lead to an interpretation of the growth curve, which will be published later.

Hitherto, not enough attention has been paid to the relative water-content of plants at different stages of growth. The only way to study it is to carry out experiments under constant conditions.

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[1] Kreusler, U., *Landw. Jahrb.*, 1877, vi, 759; 1878, vii, 536; 1879, viii, 617.

[2] Dastur, R. H., *Ann. of Bot.*, 1925, xxxix, 769.

[3] Smith, J. W., Agricultural Meteorolgy, Rural Text-Book Series, New York, 1920, p. 164.

[4] Briggs, Kidd and West, *Ann. of Appl. Biol.*, 1921, vii, 103, 202.

[5] Fisher, R. A., *Ann. of Appl. Biol.*, 1921, vii, 367.