VARIATIONS IN THE PERCENTAGE OF NITROGEN IN THE NODULES OF LEGUMINOUS PLANTS

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The discovery by Hellriegel in 1886 that the nodules on the roots of leguminous plants are essential to nitrogen fixation focused attention on these structures. Since then at least 17 papers have appeared dealing, one way or another, with the percentage of nitrogen in these organs. Nodules from 15 genera have been analyzed. From a close inspection of the data in these papers it is evident that several factors operate to modify the percentage of nitrogen in the nodules, and every one of these factors should be more clearly defined. They may operate at the same or at different periods in the development of the plant. As an illustration that they function, one worker reported 4.19% of nitrogen in the nodules of soybean whose pods were well formed, while another worker found 9.81% in the nodules of soybean whose pods were also in about the same stage of maturity.

The factors responsible for such variations have received only little consideration. Stallings (3) analyzed the nodules of soybean grown alone and grown in association with wheat, on both a productive soil and an unproductive soil. His data reveal that the nodules from plants grown on a productive soil in comparison with those from an unproductive soil contained more than twice the percentage of nitrogen. Nodules from plants grown in a nitrogen-free sand for comparison were found to contain about 0.5% more nitrogen than those from plants grown on the unproductive soil.

Wozak (5) analyzed the nodules of young and of old plants of seven genera of the legumes and found the nodules of the young plants to possess a higher percentage of nitrogen than the nodules from older plants. Joshi (2) analyzed nodules of young plants of Sann-Hemp which were taken each week for 6 weeks and noted a gradual decline in the percentage of nitrogen from 10.81 in the first week to 3.06 in the fifth week. Wilson (4) removed the nodules from one plant of Lotus corniculatus taken in October, separated them into six groups, and analyzed each group for the percentage of nitrogen in the dry material. They contained 6.82% nitrogen, but when they were washed to remove particles of soil, root fragments, and other extraneous material. It is apparent, therefore, that only nodular material was present.

The nodules were analyzed for nitrogen, employing the Kjeldahl method without modification to include nitrate and nitrite should they have been present.

In all cases at least duplicate samples were analyzed, and in many cases extra large samples were used to avoid variations that might result from unobserved extraneous material or from other causes. Any special procedures are given with the particular experiment.

RESULTS

The nitrogen content of nodules of various species was determined. It was hoped that this would help to evaluate the factors that operate to modify the nitrogen content and to provide data to compare with those of other workers who have studied the nitrogen content of nodules. In so doing, all the nodules were scrutinized again to make reasonably certain that only nodular material was present.

PREPARATION AND ANALYSIS OF NODULES

The nodules that furnished material for the analysis reported in this paper came from plants growing in soil, being well beyond the seedling stage of development. It was made to obtain nodules from plants that had been exposed to the so-called “efficient” strains of bacteria. Nodules were stripped from the roots in the laboratory and washed to remove particles of soil, root fragments, and other extraneous material. It is apparent, therefore, that both young and senile nodules may have been present in the sample. For certain tests such nodules were graded into definite sizes. This was accomplished by employing sieves with round openings of definite diameters. To aid in this separation the sieves were partly submerged in water and agitated so that the nodules equal to or smaller than the diameter of the openings in the sieve passed through before placing in an oven at 105°C for 12 hours. The nodules were scrutinized again to make reasonably certain that only nodular material was present.

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