GREENHOUSE EXPERIMENTS ON THE EFFECT OF GREEN MANURES UPON NITROGEN RECOVERY AND SOIL CARBON CONTENT

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The most efficient method of utilizing fertilizer nitrogen is ordinarily by direct application to the growing crop if efficiency is measured in terms of immediate crop yields. If an indirect fertilization system is used where some or all of the commercial nitrogen is used to produce a green crop that is later turned under, then the initial crop yields are almost invariably less. This is necessarily true since a portion of the added nitrogen remains in the soil in a slowly available condition combined with carbon. With successive additions of green manure crops the yields should gradually increase as the nitrogen tied up by earlier crops is released. This might not be true if leaching were a major factor, or if large gaseous losses of nitrogen occurred.

The aims of the present experiments were (a) to compare the efficiency with which commercial nitrogen is used by successive crops when applied with or without plant materials of different stages of maturity, (b) to determine the extent to which soil organic matter is increased by successive additions of organic materials with and without fertilizer nitrogen, and (c) to obtain evidence of any gaseous losses of nitrogen from the soil.

EXPERIMENTAL METHODS

The experiments were conducted in the greenhouse in duplicate in 2-gallon glazed pots, containing 20 pounds of Evesboro loamy sand soil. This soil was maintained at pH 6.0 and fertilized with adequate phosphorus and potassium prior to the planting of each crop.

The treatments consisted in the addition of a green manure crop and urea to each of the five successive crops. The green manure crop, millet, was not grown in the pots but was added as an outside source of organic matter. This was grown in the field, the roots and tops cut up and dried at 80° C, and added to the pots just prior to the planting of each crop. Millet of three stages of maturity, namely, 10-15 inches in height, at the heading stage, and at maturity, was used. The average carbon-nitrogen ratios of the green crops added were for mature millet 60.7, intermediate millet 35.5, and young millet 13.2. The rates of application of dry matter per acre and crop were for mature millet 2.5 and 5 tons, for intermediate millet 1.5 and 3 tons, and for young millet 1 and 2 tons. The rates for urea were 0, 40, 80, and 160 pounds of nitrogen per acre for each crop. Throughout the experiment the plant materials and fertilizers were mixed with all of the soil, and the crop planted immediately.

The indicator crops in the order grown were Sudan grass, wheat, and then three more crops of Sudan grass. These crops were harvested when the heads were forming. After drying, they were analyzed for total nitrogen, including nitrates, by the Kjeldahl method. The roots were left in the soil.

Fig. 1.—The recovery of total nitrogen by successive indicator crops receiving urea and plant materials of three stages of maturity (results for three rates of urea averaged). The sixth graph shows only the results for the larger rate of application of the green manure crops, with the intermediate results.

The recovery of total nitrogen by the successive indicator crops, fertilized with urea and green manures of three stages of maturity, are given in Figure 1. The graph shows only the results for the larger rate of application of the green manure crops, with the average values for the three rates of urea. The highest recovery of total nitrogen occurred where urea alone was added. When plant materials were supplied in addition to urea, recoveries decreased rather uniformly with increasing nitrogen, maturity and carbon-nitrogen ratio. Even with urea alone the average recovery of nitrogen for intermediate rates of application, and over the five-crop period, was only 53.3%; the corresponding figure for the treatment of urea plus a total of 25 tons of swift manure crops was 25.1%. All other treatments gave intermediate results.

EXPERIMENTAL RESULTS

EFFECT OF GREEN MANURE CROPS ON NITROGEN RECOVERY IN THE CROP

The recovery of total nitrogen by the successive indicator crops, fertilized with urea and green manures of three stages of maturity, are given in Figure 1. The graph shows only the results for the larger rate of application of the green manure crops, with the average values for the three rates of urea. The highest recovery of total nitrogen occurred where urea alone was added. When plant materials were supplied in addition to urea, recoveries decreased rather uniformly with increasing nitrogen, maturity and carbon-nitrogen ratio. Even with urea alone the average recovery of nitrogen for intermediate rates of application, and over the five-crop period, was only 53.3%; the corresponding figure for the treatment of urea plus a total of 25 tons of swift manure crops was 25.1%. All other treatments gave intermediate results.