LOSS OF NITROGEN FROM FLOODED SOIL AS AFFECTED BY CHANGES IN TEMPERATURE AND REACTION

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THE nitrogen nutrition of rice has been studied by workers at the Louisiana Agricultural Experiment Station for the past 12 years. It has been repeatedly observed that rice growing in soils low in nitrogen fails to respond proportionately to the nitrogen added in fertilizers. The relatively low response of the crop to the added nitrogen has been explained as largely due to two causes, first, an increase in the growth of weeds which may use the nitrogen before the young rice is big enough to compete for it, and, second, the loss of the nitrogen from the soil which may occur either by diffusion of soluble nitrogen into the irrigation water from which the rice plant cannot absorb it very effectively or by loss of the nitrogen completely through volatilization.

It has been the purpose of this study to determine conditions and mechanisms of the loss of nitrogen from soil subjected to treatments similar to those found in rice fields. Obviously, the amount and forms of nitrogen, the moisture content, the temperature and the hydrogen-ion concentration of the soil and water are of primary importance.

HISTORICAL

Most of the studies on rice culture have been conducted to determine the relative value of various forms of nitrogenous fertilizers, especially since early investigators found that organic or ammonium forms gave better results than nitrate nitrogen.

Nagaoka, cited by Kelley (10), in 1904 conducted pot experiments using various forms of nitrogen to fertilize rice and found that, while ammonium sulfate gave consistently good results, the results obtained with the nitrate form were quite variable. He concluded that the nitrate nitrogen was about 40% as effective as ammonium sulfate. Kelley (10), working in Hawaii with both field and laboratory experiments, found ammonium sulfate far superior to the nitrate form of nitrogen for rice. Organic nitrogen gave better results than nitrates but was not as effective as ammonium nitrogen. He recommended that nitrate not be used to fertilize irrigated rice. In later work, he (11) showed that upon flooding the soil the nitrates were reduced to nitrites which were toxic to the rice. The usual procedure in Hawaii was to plow the land after harvest and allow it to remain fallow until another rice crop was planted. Kelley recommended that this practice be discontinued since the nitrates produced in the fallow soil would be reduced to nitrites and become toxic upon flooding or leach out of the soil. On the Hawaii soils fertilizers which did not contain nitrogen gave no increase in yields. The importance of supplying organic matter to soil on which rice was grown was emphasized by Harrision (6). His results on experiments comparing the ammonium and nitrate forms of nitrogen were similar to those of former workers.

Harrison and Aiyer (7) observed that as a result of the decomposition of organic matter in swamp rice soils methane gas was produced by flooding the soil and nitrates produced in the soil were rapidly denitrified. They found the rice crop was able to obtain its required form of ammonia which was produced as a result of decomposition of green manure and from that produced through the denitrification of nitrates. Paulino (13) found ammonium sulfate to be superior to either ammonium nitrate or calcium nitrate in the production of rice in the Philippine Islands.

Willis and Carrero (19) conducted experiments in Puerto Rico using a calcareous soil in 5-gallon pots flooded to a depth of 1 to 2 inches and studied the effects of various forms of nitrogen upon the nutrition of the rice plant. They found that no chlorosis of rice occurred when ammonium sulfate was used as a fertilizer, but chlorosis did result when sodium nitrate, calcium nitrate, or mono-ammonium phosphate was used. These workers explained the results obtained with these four compounds by the fact that iron was precipitated by the latter three as an unassimilable radicle in the ammonium sulfate served as a solvent for iron. They further offered this explanation to account for results obtained by other investigators, that is, the inferiority of nitrates as compared to the ammonium form of nitrogen for nutrition of the rice plant.

It has been demonstrated by Lebedjantzen (12) that certain chemical changes which occur during the drying of soils result in an increase in the solubility of the materials. He noted an increase in soil nitrogen and in a very large increase in ammonia nitrogen, an increase in amide nitrogen, and a sharp decrease in nitric nitrogen upon the nutrition of the rice plant. He explained the increase in soil nitrogen and in the ammonia nitrogen as largely due to two causes, first, an increase in the water content of the soil and by the season, and second, the loss of the nitrogen from the soil which may occur either by diffusion of soluble nitrogen into the irrigation water from which the rice plant cannot absorb it very effectively or by loss of the nitrogen completely through volatilization.

Vibar (18) reported dried blood to be the best form of nitrogen used on rice in the Philippine Islands. The effectiveness of ammonium sulfate was influenced by the water content of the soil and the acidity. Sodium nitrate was toxic to lowland rice but worked well in upland rice.

Subrahmanyan (16) studied the effect of water-logging on two soils, one cultivated and heavily manured and the other a garden soil from South America, and reported that ammonium nitrate was the most effective fertilizer. Subrahmanyan (16) reported dried blood to be the best form of nitrogen used on rice in the Philippines. The effectiveness of ammonium sulfate was influenced by the water content of the soil and the acidity. Sodium nitrate was toxic to lowland rice but worked well in upland rice.

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