# The Effect of Five Fungicides on Soil Respiration and Some Nitrogen Transformations in Yolo Fine Sandy Loam[1]

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The quantity and number of fungicides used for seed and soil treatment have increased considerably in the last few years (1). The interaction of several fungicides with soil organisms has been reviewed (2, 3, 4,) but information is lacking for many of the newer fungicides. In general, the soil saprophytic fungi are less easily killed than pathogens (2), but other desirable organisms such as the autotrophic soil nitrifying bacteria are sensitive to many fungicides (3).

The experiments reported here examine the effect of five fungicides on 1) overall biological activity in soil by measurement of oxygen uptake in a Warburg respirometer, 2) the oxidation of ammonium-N to nitrite-and nitrate-N, and 3) nitrogen mineralization as measured by increase in total inorganic N.

## Procedure

Yolo fine sandy loam from the 0 to 8 inch horizon was collected in the field, air dried, and passed through a 2 mm sieve.

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The following technical grade fungicides were used for soil treatment:

Lanstan 1-chloro, 2-nitropropane

Botran 2,6-dichloro, 4-nitroaniline

TCNB 1, 2, 4, 5-tetrachloronitrobenzene

Chemagro 2635 An isomeric mixture of 80% 1, 2, 5-trichloro 4, 6-dinitrobenzene and 20% 1, 2, 3-trichloro 4, 6-dinitrobenzene

PCNB 1, 2, 3, 4, 5-pentachloronitrobenzene

Effect of Fungicides on Soil Respiration

The method used to determine soil respiration was basically the Webley (5) modification of the Warburg technique. The water bath was maintained at 30°C and 0.5 ml of 20% KOH was used as a carbon dioxide absorbent.

To insure that an active microbial population was present in the soil used in these experiments, the soil was incubated at 25°C at 1/3 bar moisture tension for three weeks following the incorporation of 1% alfalfa meal. The fungicides were applied at 10, 100 and 1000 ppm. Lanstan, PCNB, TCNB, and Chemagro were dissolved in hexane and Botran in acetone. The fungicides solutions were pipetted onto one gram portions of air dry soil contained in twenty ml beakers. The beakers were placed on a warm hotplate (50°C) until the solvents had evaporated. The dry soil containing fungicide was then mixed with sufficient incubated soil to bring the total dry-weight to 4 grams. Oxygen consumption in triplicate samples was followed for approximately 60 hours.

Control soil samples receiving no fungicide were included in each run.

Effect of Fungicides on Nitrogen Transformations

Triplicate 50 gram samples of air dry soil contained in 125 ml erlenmeyer flasks were treated with the fungicides dissolved in small quantities of the solvents mentioned previously. Lanstan, which is a liquid at room temperature, was applied to the soil directly with a syringe. The flasks were stoppered for three hours to prevent the loss of this volatile compound and shaken intermittently to enhance the dispersion of the fungicide. All the fungicides were applied at 100 ppm and if this concentration had no effect 1000 ppm was used in the next run. Compounds which were toxic at 100 ppm were then tested at 10 ppm. Prior to incubation the flasks were left unstoppered for six hours to allow the solvents to evaporate, then the soil was moistened with 10 ml of water containing ammonium sulfate equivalent to 100 ppm N, soil basis. The samples were incubated in controlled temperature chambers at 30°C and aerated continuously with air saturated with water vapor. The flasks were removed at intervals for analysis. The soil samples were extracted with 1 N KCl and the exchangeable ammonium determined by steam distillation with MgO. Ammonium plus nitrate was determined on another aliquot of the extract after addition of MgO and Devarda's alloy as described by Bremner (6). Nitrite determinations were made by the colorometric method of Rider and Mellon (7).

## Results and Discussion

Data on the influence of fungicides on oxygen uptake are presented in figure 1. Lanstan at 10 and 100 ppm showed a marked

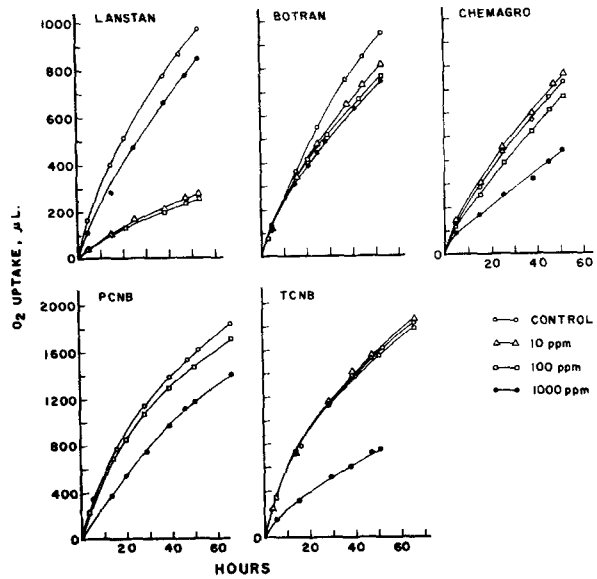


Figure 1. Oxygen uptake in Yolo fine sandy loam as affected by five fungicides.

depression of soil respiration, whereas, at 1000 ppm the effect was slight. In view of this apparently anomalous behavior, the experiment was repeated and identical results obtained. A possible explanation is that some soil organism or organisms was adapted to utilization of Lanstan as a substrate and that at the 1000 ppm level sufficient of this compound was present to materially influence total oxygen uptake. The inhibitory effect of Botran was slight at all levels of addition and only at 1000 ppm was

there a pronounced inhibition due to the addition of Chemagro. PCNB and TCNB affected oxygen uptake only at 1000 ppm. Oxygen uptake is an overall indicator of soil activity and generally is depressed by non specific fungicides and soil fumigants. Specific fungicides have less effect, as shifts within the soil population are not necessarily reflected by oxygen uptake (2). The data presented in figure 1 generally substantiate these conclusions.

Figure 2 gives curves for increases in nitrate nitrogen as a

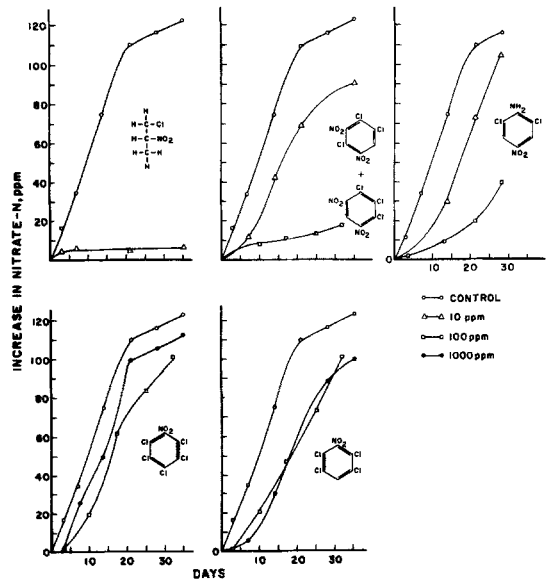


Figure 2. Influence of five fungicides on rate of nitrification in Yolo fine sandy loam.

function of time of incubation and provide a measure of the rate of nitrification of the added ammonium. Lanstan completely inhibited nitrification at 10 ppm. Chemagro reduced the nitrification rate at 10 ppm and very pronounced inhibition was evident at 100 ppm. Botran progressively inhibited nitrification with complete inhibition being shown at 1000 ppm. On the other hand, the influence of PCNB and TCNB on nitrification was slight even at 1000 ppm. These results suggest that a reduction in the number of chlorines on the benzene ring and the introduction of an amino group or of another nitro group increases the toxicity of substituted nitrobenzene fungicides to the nitrifying bacteria. To a lesser extent oxygen uptake was influenced by the introduction of amino and nitro groups. Lanstan is the least specific of the fungicides tested and had the greatest inhibitory effect on nitrification. Botran and Chemagro are specific fungicides but were more toxic than either TCNB or PCNB.

Since only traces of nitrite were observed during the experiment there is no evidence that the inhibition on nitrification, where it occurred, affected only nitrite oxidation.

Some inhibition of nitrogen mineralization was exhibited by all fungicides as shown in the table. Although Lanstan was very toxic to nitrification, it had little influence on nitrogen mineralization at 100 ppm. At the same concentration, Chemagro depressed nitrogen mineralization substantially. Results for Botran were erratic and are not reported. This may have been due to partial mineralization of the amino nitrogen in this compound.

TABLE 1

Influence of fungicides on nitrogen mineralization in Yolo fine sandy loam during 35 days incubation.

| Fungicide | Concentration in soil, ppm | Net increase in inorganic N, ppm |
|---|---|---|
| None | -- | 25 |
| Lanstan | 10 | 21 |
| | 100 | 21 |
| Chemagro | 10 | 18 |
| | 100 | 8 |
| PCNB | 100 | 16 |
| | 1000 | 16 |
| TCNB | 100 | 27 |
| | 1000 | 15 |

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