present series of trials were designed to find a safe and effective insecticide for controlling these borers and to obtain information on factors that might affect the effectiveness of such chemical control.

All insecticides tested were found to significantly reduce borer infestation and stand loss especially on late maize. Mean yields from treated plots were, however, not significantly different from those of control plots in all trials.

Carbaryl (i.e. Sevin) either as 85% W.P. or 5% dust was recommended for controlling borer infestation on late maize but not on maize grown on poor soil with low water content.

These results were discussed in terms of the pattern of borer infestation observed on untreated plots during the period of the trials and also from results of maize population studies.

In conclusion, no significant treatment effects on yields were obtained in both early and late season trials probably because of usually low levels of stem borer infestation on the early crop and because of the usually low fertility and moisture conditions during the late season.

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Effect of 2-Chloro-6-(Trichloromethyl) Pyridine* on Conserving Ammonium Fertilizers in a Tropical Rain Forest Environment

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ABSTRACT

THE effect of 2-chloro-6-(trichloromethyl) pyridine, known as N-serve, on the conservation of ammonium sulphate was investigated under field conditions in two soils in Ibadan, Nigeria. 40 ppm. of N-serve was not effective in conserving ammonium sulphate while 120 ppm. was partially effective for a short period. Its ineffectiveness was attributed to high soil temperature. The use of N-serve does not assist in conserving ammonium nitrogen in the soil under the conditions of this experiment, and we do not consider it to be of agronomic significance.

INTRODUCTION

Efficient utilization of both soil and fertilizer nitrogen has been a major concern of agronomists for many years. One of the most important factors responsible for inefficient use of nitrogen is leaching. This is particularly the case in areas where rainfall is high and nitrification occurs at a rapid rate. Any factor that can slow down the speed of nitrification will cut down on the leaching loss of nitrogen.

* Thanks are due to the Dow Chemical Company, Midland, Michigan, U.S.A., for the free supply of this chemical.

Recently, Goring (1962a) reported that 2-chloro-6-(trichloromethyl) pyridine (trade name, N-serve) is capable of controlling nitrification by killing the bacteria which oxidize ammonium to nitrite. Goring (1962a) showed that when entire soil samples were uniformly treated in closed containers with 1 to 10 ppm. of N-serve, over 90 percent of the ammonium nitrogen added to the soil was recovered unnitrified after a period of twelve weeks of incubation. When attempts were made to simulate fertilizer situations in the field, Goring (1962b) observed that similar concentrations of N-serve gave partial control of nitrification which was high enough to be of agronomic importance. In a field study, Turner, Warren and Andriessen (1962) obtained results similar to those of Goring (1962b). Working under irrigation conditions, Swezey and Turner (1962) obtained higher yield increases in cotton, sweet corn, and sugar beets with nitrogen fertilizers treated with N-serve than with untreated fertilizer nitrogen applied to soil either in one or two dressings. The difference in yield was attributed to the partial control of nitrification by N-serve, and subsequent reduction in nitrogen losses through leaching.

Both nitrification and the subsequent loss of nitrate through leaching proceed at a faster rate in the humid tropics than in the temperate region. There is, therefore, a need to control nitrification under cropping conditions in the humid tropics. The object of the experiment being reported was to investigate the effectiveness of N-serve in conserving ammonium fertilizer in the soil in a tropical rain forest environment.

MATERIALS AND METHODS

Experimental area

The experimental site was situated on the University of Ife farm, Ibadan, which lies within the Low Rain Forest Zone (Keay, 1959). The mean annual rainfall in Ibadan is 51 inches; that on the farm from 1963 to 1965 was 56 inches.

The first experiment was conducted during the dry season (January to February, 1966) on an alluvial sandy loam while the second experiment was conducted during the rainy season (April to May, 1966) on an Iwo sandy soil. Some of the characteristics of these soils are presented in Table 1.

Treatments

The following treatments were applied to the soils:
(a) Ammonium sulphate treated with N-serve;
(b) Ammonium sulphate without N-serve;
(c) Control, containing neither ammonium sulphate nor N-serve.

A preliminary study in the laboratory showed that when N-serve was band placed without fertilizer in 200 g. of soil in pots there was no difference between the amount of ammonium nitrogen obtained from the N-serve treated and the untreated soils. It was, therefore, not considered necessary to add N-serve to the control. Each treatment was replicated eighteen and twelve times for the first and second experiments respectively. Ammonium sulphate was applied at the rate of 1 g. per 200 g. of soil (approximately 2,000 pp2m. N) in both experiments.

Experimental procedure

Ammonium sulphate was treated with N-serve as follows: The required amount of N-serve was dissolved in acetone and added to a predetermined quantity of ammonium sulphate in a petridish. The mixture was stirred and the acetone allowed to evaporate at room temperature (25°C.). By this process the fertilizer became uniformly coated with N-serve. The concentrations of N-serve were 4 and 12 percent of the nitrogen content in the fertilizer for the first and second experiments, respectively.

Ammonium sulphate was band placed at a depth of 0 — 3 inches in the soil (Figure 1). Soil samples were obtained from the experimental site and passed through a 4-mm. sieve. 150 g. of the soil sample was placed in a wax coated paper cup, 3.2 inches high with a diameter of 2.0 inches at the bottom and of 2.8 inches at the open end (internal measurements). One gram of ammonium sulphate was spread evenly on the soil surface and 50 g. of soil was then added to fill the cup to the rim level (Figure 1). The control cups were filled with 200 g. of untreated soil samples. The cups were buried in three rows in a shallow pit dug at the same site where the soil samples were obtained. The rows were six inches apart; the distance between the cups in each row was six inches; and there were 12 to 18 cups in each row.

Table 1. Some Physical and Chemical Characteristics of the two Soils used for the study

Depth (inches)	*Mechanical analysis, % fine earth*				*pH*	*Cation exchange capacity, m.e./100 g. soil*	*Organic carbon, %*	*Kjeldahl nitrogen, %*
	Coarse Sand (2.0-0.2 *mm.*)	*Fine Sand* (0.2-0.02 *mm.*)	*Silt* (0.02-0.002 *mm.*)	*Clay* (<0.002 *mm.*)				
Alluvial Sandy Loam								
0 — 6	56.7	33.3	4.3	4.7	6.5	4.5	0.92	0.08
6 — 12	53.4	38.8	3.0	4.2	6.6	3.4	0.44	0.04
Iwo Series (Sandy variation)								
0 — 6	53.2	34.2	5.1	6.0	6.7	9.3	1.42	0.11
6 — 12	51.0	29.4	4.6	13.3	6.6	4.2	0.64	0.06

The cups were covered with 2 inches of soil so that the fertilizer band was approximately 3 inches below the soil surface (Figure 1). The positions of the cups were randomized in all cases.

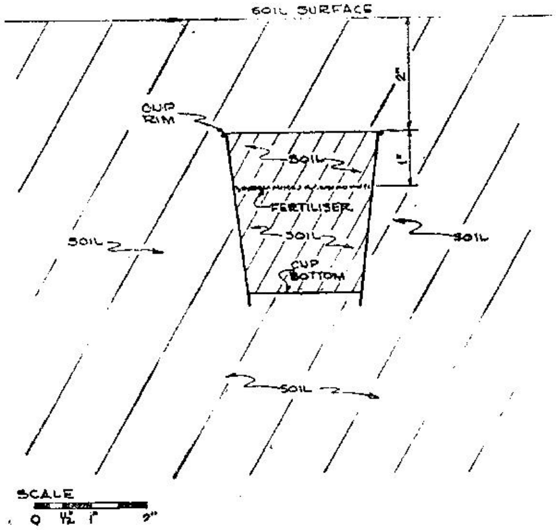

Figure 1. Schematic representation of one of the paper cups buried in the soil for the study of the effect of 2-chloro-6-(trichloromethyl) pyridine on conserving ammonium sulphate.

Four holes were punched at the bottom of each cup to allow for drainage. During the dry season, the soil in the cups was watered twice a week. No watering was done in the wet season as the soil was reasonably moist throughout the duration of the experiment.

Three cups of each treatment were removed at weekly intervals over a period of 6 weeks for analysis of ammonium nitrogen. Approximately 200 g. of soil sample was obtained by scraping off any soil above the level of the rim of the cup as well as any soil adhering to the external walls of the cup. The entire soil in the cup was extracted with acidified 10 percent sodium chloride solution, using a ratio of 1 g. of soil to 5 ml. of solution. 10-ml. aliquots of the extracts were distilled with NaOH into boric acid, using the micro-Kjeldahl apparatus. The distillate was titrated against 0.01N hydrochloric acid solution. Ammonium nitrogen recovered from the fertilizer added to soil was calculated from the difference between the titration values for the control and the treated samples.

pH was determined by means of a glass electrode, using a soil paste. Organic carbon was determined by a modified Walkley-Black procedure (Smith and Weldon, 1940); nitrogen by the Kjeldahl method, using a sodium sulphate — copper sulphate — selenium catalyst mixture. Cation exchange capacity was determined as follows: the soil was leached with a normal neutral ammonium acetate solution and excess ammonium ions were removed by washing with methyl alcohol. The soil was then leached with an acidified 10 percent solution of sodium chloride. The sodium chloride leachate was distilled with magnesium oxide, the ammonia being collected in four percent boric acid solution and titrated against a standard hydrochloric acid solution. Silt and clay fractions were measured by the hydrometer method of Bouyoucos (1951); fine sand by decantation; and coarse sand by sieving.

RESULTS AND DISCUSSION

There was little difference between the amount of ammonium nitrogen recovered from the N-serve treated and the untreated samples during the dry season (Table 2). This was not in agreement with the results of Goring (1962b) and Turner *et al* (1962) in which significant partial control of nitrification was obtained with a concentration of N-serve which was as low as 0.5 percent of the nitrogen content in the fertilizer used.

Table 2. Percent Recovery of Ammonium Nitrogen from N-serve treated Ammonium Sulphate Band placed in soils under field conditions

Season	*Concentration of N-serve**	*1st week*	*2nd week*	*3rd week*	*4th week*	*5th week*	*6th week*
Dry (January	0	97	54	29	42	30	32
to Feb. 1966)	4	92	60	37	39	31	37
Wet (April	0	62	46	23	24	2	0
to May, 1966)	12	69	50	40	37	29	11

* Expressed as percent of nitrogen content in the fertilizer.

However, when the concentration of N-serve was increased to 12 percent of the nitrogen content in the fertilizer, it partially conserved ammonium nitrogen in the soil (Table 2). With this high concentration of N-serve 11 percent of the added ammonium nitrogen was recovered six weeks after the treatments were imposed. Again, this was not in agreement with the findings of Goring (1962b) and Turner *et al* (1962). When Goring treated ammonium sulphate with N-serve (concentration, 1 percent of the nitrogen content in the fertilizer) he recovered 51 percent of the ammonium nitrogen after 16 weeks of the treatment. In a study with anhydrous ammonia treated with N-serve (concentration, 2 percent of the nitrogen content in the fertilizer), Turner *et al* (1962) recovered 50 percent of the ammonium nitrogen in the fertilizer after 17 weeks of application.

In this study the ability of N-serve to conserve ammonium nitrogen was very low. This may be due to a prevalent high soil temperature during the experimental periods. N-serve is a volatile compound, and considerable loss may result under high temperature conditions thus making it an ineffective inhibitor of nitrification. Goring (1962b) and Turner *et al* (1962) obtained their data at soil temperatures of 70°F and 40 to 55°F, respectively. Observations on yam plots adjacent to the experimental plot indicated that soil temperature ranged between 89 and 95°F during the experimental period. This temperature range was much higher than those under which Goring (1962b) and Turner et al (1962) conducted their experiments. The soils on the farm were rather porous (80 — 92 percent sand, Table 1). In addition to the high temperature, the porosity of the soils would be a factor accelerating the loss of N-serve through volatilization.

The concentration of N-serve (120 ppm. N-serve) which assisted in partially conserving ammonium nitrogen in this study is several times greater than that observed to be toxic to many crops (Goring 1962a; Mckell and Whalley, 1964). It may be concluded that under the conditions of this experiment the use of N-serve at concentrations that are not toxic to plants will not prevent a rapid loss of ammonium fertilizers in the soil. This conclusion may also hold true for other tropical rain forest areas where high soil temperatures generally prevail.

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Preliminary Studies on the Epidemiology of *Phytophthora palmivora* Butler. II. Effects of Relative Humidity on Growth, Sporulation and Viability

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INTRODUCTION

TOWARDS the end of 1963, casual inspections carried out in some cocoa plots in Ibadan showed that sporangia of *Phytophthora palmivora* obtained from cocoa pods attacked by the pathogen appeared empty and dead. During the 1964 cocoa season similar observations were also made and it was found that the amount of aerial hyphae and sporangia produced on *Phythophthora*—infected cocoa pods determined by subjective visual estimation of the whitish mycelial tufts on black-pods, varied with the time of the year.

As a result of these observations, it was suggested that the production of sporangia by *P. palmivora* might be affected by environmental factors such as temperature and humidity, and that the dry atmospheric conditions which prevail during the 'harmattan' months from November to January might play an important role in the survival of the fungus on cocoa pods. Consequently, the following experiments were carried out to investigate the effects of humidity on *P. palmivora* under laboratory conditions.

MATERIALS AND METHODS

Different relative humidities were obtained by using saturated solutions of various salts viz:- Magnesium chloride (33% relative humidity); potassium carbonate (43%); magnesium nitrate (52%); sodium nitrite (63%); ammonium sulphate (80%); potassium nitrate (91%); potassium sulphate (96%); and distilled water (approximately 100%).

Growth and sporulation of *P. palmivora* at different relative humidities.

Small amounts of the above solutions (in contact with excess salt in each case) were poured into 25 mm. diameter boiling tubes. Strips, measuring 10 x ½ x ½ cm; were cut from cocoa pods and suspended in the tubes by means of adapted fishing hooks, and aluminium caps were placed over the mouth of the tubes. The latter were autoclave-sterilised and then sealed in 35 mm diameter polythene bags for two weeks to bring the water content of each strip into equilibrium with that of the atmosphere within the tube.