can be tested in 3 hr, eliminating the need for more time-consuming chemical analyses, and up to four soils can easily be tested at the same time, by suitable arrangement of the apparatus. At present, soils from every town receiving DDT residual spraying in Mexico are being analyzed and classified.

The problem of very rapid decomposition of DDT when in contact with some soils demands the development of a practical method to avoid such decomposition. Laboratory tests we have made of the duration of DDT residual deposits on whitewashed surfaces confirm the observations of Maier *et al.* (*9*) and of Hadjinikolau and Busvine (*16*) that such surfaces retain DDT activity for relatively long periods of time. Hadaway and Barlow (*17*) report rapid loss of DDT activity on whitewash when sprayed with kerosene solutions and emulsions. The whitewash they used contained Fe (calculated as 2.6% Fe_2O_3). Further work of Barlow and Hadaway (*18*) with suspensions of water-wettable powder gave much better results. Furthermore, Clapp *et al.* (*7*) show that adding salt to the whitewash mixture lengthens the time of action of the DDT. It is probable that Maier's recommendation that walls be whitewashed before being sprayed with DDT will provide a solution to the problem presented, provided that whitewashes with low Fe content are used. A field trial of this hypothesis is now under way at Tuxpan, Guerrero. A search is also being made for substances which, when mixed directly with the DDT suspensions in the spray tanks, may inhibit the rapid decomposition of the DDT through inactivation or blocking of the catalyst, and still be cheap enough to be used in control campaigns.

Here it may also be remarked that DDT-kerosene solutions applied to adobe not only will carry the DDT in solution deeper into the adobe, out of effective range as a contact insecticide, but will also place the DDT in much closer contact with the Fe in the adobe than when DDT suspensions are used. This may help in clarifying further the relative inefficiency of such DDT-kerosene solutions, reported earlier by Barlow and Hadaway (*18*).

The reported observations may also have a bearing on problems presented by the use of DDT in agriculture. Detoxification of DDT-poisoned soils by dilute $FeCl_3$ solutions is a possibility.

Addendum: Since this manuscript was submitted for publication a paper describing the change in physical status of DDT applied to mud surfaces has appeared (*19*). We have also observed this phenomenon, including the loss of DDT activity biologically long before it disappears chemically. We feel that sorption is the first step in the process of catalytic decomposition. Sorption, in soils high in iron, takes place very rapidly (in Michoacan #1, 7 days for a 250 mg/sq ft deposit of DDT), and the reaction of catalytic decomposition at normal environmental temperatures delays for weeks or months. The reaction of catalytic decomposition at 130° C affords a rapid method for foretelling the capacity of a soil for inactivating DDT.

References

1. MUIRHEAD-THOMSON, R. C. *Bull. Entomol. Research,* **38,** 449 (1947).
2. ———. *Nature,* **163,** 109 (1949).
3. WHARTON, R. H., and REID, J. A. *Ibid.,* **165,** 28 (1950).
4. SWELLENGREBEL, N. H., and LODENS, J. G. *Documenta Neerlandica et Indonesia de Morbis Tropicis,* **1,** 245 (1949).
5. BERTRAM, D. M. *Ann. Trop. Med. Parasitol.,* **44,** 242 (1950).
6. DOWNS, W. G., and BORDAS, E. *Am. J. Hyg.,* **53,** 217 (1951).
7. CLAPP, J. M., FAY, R. W., and SIMMONS, S. W. *U. S. Pub. Health Service. Pub. Health Repts.,* **62,** 158 (1947).
8. SUNDARARAMAN, S., and PEFFLY, R. L. *J. Natl. Malaria Soc.,* **8,** 267 (1949).
9. MAIER, J., RENDTORFF, R. C., and SUAREZ, M. *Am. J. Trop. Med.,* **28,** 889 (1948).
10. GAUD, J., MECHALI, D., and CLIER, J. L. *Bull. Inst. Hyg. Maroc,* **8,** 35 (1948).
11. PURI, I. M. *Indian J. Malariol.,* **1,** 211 (1947).
12. DOWNS, W. G., COLORADO IRIS, R., and GAHAN, J. B. *Am. J. Trop. Med.,* **28,** 741 (1948).
13. *Official Methods of Analysis of Association of Official Agricultural Chemists* (7th ed.) Washington, D. C.: par. 3.45 (1950).
14. JEFFRIES, C. D. *Soil Sci. Soc. Am. Proc.,* 211 (1946).
15. FLECK, E. E., and HALLER, H. L. *J. Am. Chem. Soc.,* **66,** 2095 (1944).
16. HADJINIKOLAU, J., and BUSVINE, J. R. *Bull. Entomol. Research,* **39,** 179 (1948).
17. HADAWAY, A., and BARLOW, F. *Ibid.,* **38,** 489 (1947).
18. BARLOW, F., and HADAWAY, A. *Ibid.,* 335.
19. HADAWAY, A. B., and BARLOW, F. *Nature,* **167,** 854 (1951).

A Simple Humidifying System for a Small High-Humidity Room[1]

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In attempting to construct and set up an *Avena* assay room,[3] the problem of producing and maintaining constant humidity at abnormally high levels (80–90% relative humidity) is one of primary consideration. In addition, the room must be thermostatically controlled (24°–26° C). Therefore, any method of humidification involving the use of heat, such as heating coils in a water bath, must fall within the range of the temperature tolerance (1°–2° C). In order to avoid the possible difficulty that the latter method poses, a simple, nonheating humidifying system was devised. A spray-atomizer–type humidifier, designed for a room of about 500 cu ft, was used.

The humidifier (Fig. 1 and Fig. 2, *D*) was constructed from No. 28 gauge galvanized iron, by locking and soldering. The baffle and top bracket, the latter of which holds the humidifier to the ceiling, were riveted onto the cylinder. A metal lip extends out (Fig. 1, *B* and *C*) from the front at the base of the opening. The purpose of this is to catch occasional drops of water that collect because of the direction of air flow, on the top edge of the front opening; it also serves to force the misty vapors upward, allowing for

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[3] A darkroom for the specific bioassay determination of plant auxins, using the Went *Avena* technique.

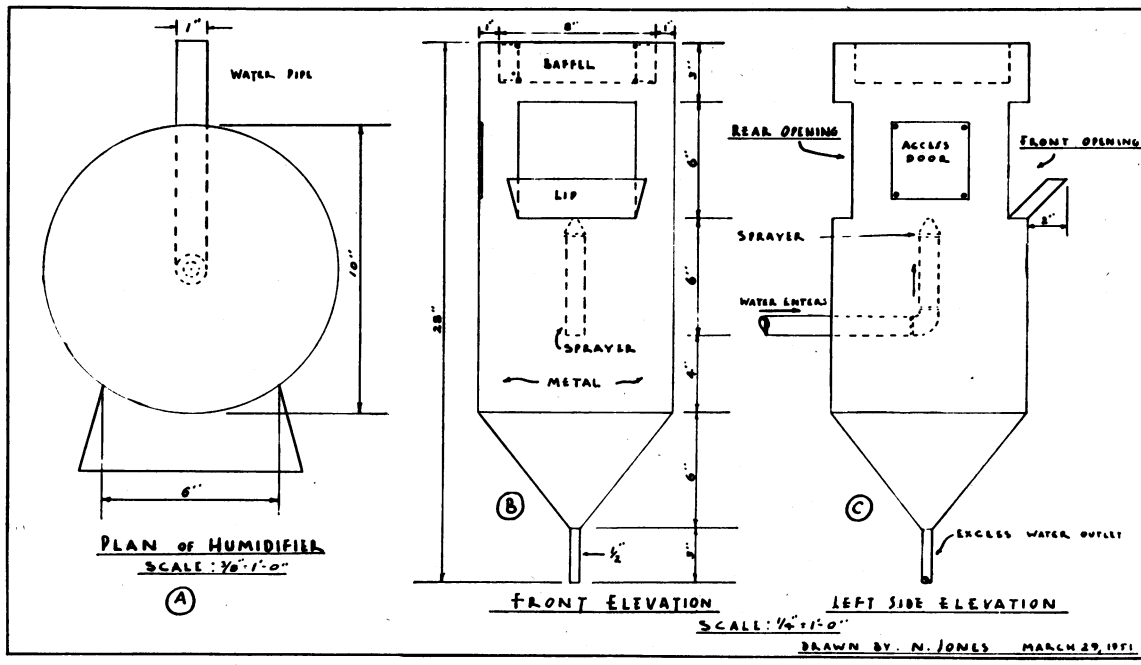

FIG. 1.

more efficient and uniform dispersion. An access door (Fig. 1, *C*) is provided for alterations or for regulating the spray while the system is in operation. This opening is made leakproof by sealing off with a rubber or cork gasket and screwing tightly into place. An excess water outlet is provided for the runoff water (Figs. 1 and 2).

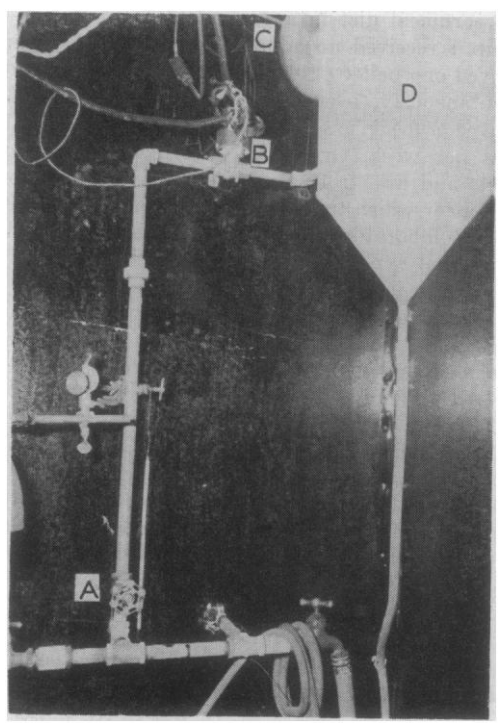

FIG. 2.

The atomizer runs from a normal wall outlet, using 3/8″ galvanized pipe with a valve (Fig. 2, *A*) (needle valve preferably) to adjust the flow. (A fine to coarse screen may be placed ahead of the valve to eliminate debris from clogging the valve.) Interspaced between the valve and the spray is a solenoid valve (Fig. 2, *B*), controlled by a Minneapolis-Honeywell humidistat (No. H63A), which maintains relative humidity within ±2%. The atomizer used in this instance is a brass jet made for an oil heating furnace at oil pressures of 100 lbs, fitted with a fine brass screen cylinder contained in a cartridge just in front of the very small aperture (*ca* 0.01″ in diam). Any atomizer-type nozzle may be used as long as the particle size of the water spray is not too large and the spray pattern is uniform and, preferably, wide-angled.

A small, 110–115 v, 8″ fan (Fig. 2, *C*), for circulating the air around the room, as well as for forcing the spray vapors out into the room, is placed about 15 in. to the rear of the humidifier. This fan, which is of the type generally used as part of the freezing unit in refrigerators, runs continuously. A similar fan (of opposite rotation for suction) is placed over the door; this fan pulls fresh air into the room by way of a louvred vent (*ca* 6″ × 8″) located near the floor on a side wall near the rear of the room and forces it out through a similar vent over the door and close to the ceiling in the front of the room. The fan is located on the outside of this latter vent. This system renews the air in the room at a relatively slow rate; as a consequence no drafts or currents occur that are obvious to the operator or that in any noticeable way affect the plants.

In this particular setup no constant temperature controls are needed, since the incoming air is already

controlled by a thermostat in the outside room such that the *Avena* room is maintained at 25° C (±1°). If it were necessary to thermostat the room, it could be done easily by installing in place of the small 8″ fan behind the humidifier, a blower-type electric heater in conjunction with a thermostatic control.

In the present situation when the relative humidity drops below 84%, the humidistat closes and magnetizes the solenoid which opens the valve, allowing the atomizer to begin spraying. The system cuts off at 88% relative humidity. The rate of spray is controlled by the valve in the water line. With the present valve type (normal gate valve), when the water comes through at full pressure (*ca* 45#), the spray is on a 4-min on, 20-min off cycle; with the valve cut down about two thirds the spray is on a 10-min on, 18-min off cycle. Thus, by controlling either the valve opening or the size of the spray aperture, one might obtain several humidity ranges and schedules.

The best index of the efficiency of this humidifying system, which next to the absence of light is probably the most critical factor in the construction and operation of an *Avena* room, is the response of the *Avena* seedlings and the coleoptiles in the assay itself. This has proved excellent. The plants follow the usual 3-day schedule and at the end of this period are between 20–30 mm tall and, most importantly, are not tough, fibrous, or brittle when pulled. A novice at the art of *Avena* assaying has run the test over a period of more than 12 weeks, involving more than 25 runs with about 120 plants per assay. The loss of plants due to decapitation or pulling of primary leaf has been less than 100 plants out of roughly 3,000, or about 3%. Originally, standards[4] of 25 and 50 γ/l were used, but it was found that 50 γ/l gave consistently limiting curvature (> 20°) and averaged 20°. The average of 11 standards at 25 γ/l was 16°, with 3 of these exceeding 20° curvature. It was decided then to use standards at 20 and 10 γ/l. These have proved satisfactory, giving an average of 16° for 20 γ/l and 10° for 10 γ/l. It is obvious that even 20 γ/l produces some limiting curvatures. This indicates good sensitivity of the plants. On this basis, it is probably valid to say that the conditions of the room, of which humidity is the prime control, are quite satisfactory.

[4] In all cases there are 12 single plants to a row; i.e., to each sample or concentration of auxin.

Competitive Action of 2-Thiouracil and Uracil in AAF-induced Cancer of the Liver[1]

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We have shown previously that the incidence of cancer of the liver induced in rats by feeding the carcinogen 2-acetylaminofluorene (AAF) is significantly decreased by simultaneous administration of 2-thiouracil (*1*). Kidder *et al.* have shown that in the animal microorganism *Tetrahymena geleii* 2-thiouracil acts as an antagonist to uracil and inhibits growth (*2*). Mammals differ from *Tetrahymena geleii* in their requirement for pyrimidines and purines, the latter being unable to synthesize these substances, whereas the former can (*3*).

In some respects the requirements of mammalian cancer cells resemble those of *Tetrahymena geleii* rather than those of normal mammalian tissue; certain guanine analogs competitively inhibit growth of *Tetrahymena geleii* and mammalian cancer, but not of normal mammalian tissue (*4*). It was therefore considered of interest to determine whether the action of 2-thiouracil in inhibiting AAF-induced liver tumors might be due to competition with uracil.

It was not felt desirable to incorporate uracil in the diet because the acceptance of such food by the rat is poor; the animals would therefore not receive uniform quantities of either uracil or carcinogen. Consequently the uracil was administered by stomach tube in aqueous suspension stabilized with glycerin.

Kidder *et al.* (*2*) found the uracil: thiouracil inhibition index to be 100 in *Tetrahymena geleii.* On this basis, assuming the absorption of thiouracil from pellets to be 5–10 mg per day in the rat (*5*), the daily uracil requirement would be 500–1,000 mg. This amount of uracil proved to be too toxic, but 250 mg daily was tolerated by some animals, although the mortality was high even at this dosage level.

Four groups of male rats (Wistar descendants) were studied; all animals received AAF, incorporated in a cornmeal diet in a concentration of 0.03% (*6*). Group I received no additional treatment. Group II received one pellet (214 mg) of thiouracil,[2] implanted subcutaneously, every 2 weeks (*5*). Group III received 250 mg uracil by stomach tube once daily, 6 times per week. Group IV received both thiouracil pellets and uracil. This regime was continued for 90 days, after which time all animals were transferred to a stock laboratory diet (Purina dog chow). It is known that exposure to this carcinogen for 90 days is sufficient to induce carcinoma (*7*). Animals were sacrificed and examined at various intervals up to 415 days.

In a second experiment, two groups of male rats received thiouracil in drinking water (0.05%). One half the animals received 250 mg uracil by stomach tube once daily, 6 days per week; all animals received a stock laboratory diet (Purina dog chow). All were killed after 35 days, the thyroid was dissected and weighed rapidly on a Roller Smith torsion balance, fixed in Bouin solution, and examined histologically.

Animals receiving AAF alone (Group I) showed severe liver changes (Table 1). The previously reported protective influence of thiouracil (*1*) was evidenced by the occurrence of hepatoma in only one of 16 animals (Group II). Simultaneous administra-

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[2] The thiouracil pellets were supplied by the Lederle Laboratories through the courtesy of St. M. Hardy.