ment resulting in 66, 76, 92, and 92 percent bolting respectively in the first four plantings in the 1962-63 experiment. Generally, in both seasons, first seedstems appeared and maximum flowering was obtained most rapidly as transplanting advanced from the hotter fall months to the later, cooler December and January transplanting dates.

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EQUIPMENT FOR THE APPLICATION OF PLASTIC AND PETROLEUM RESIN EMULSIONS[1]

W. T. SCUDDER AND J. F. DARBY[2]

Research on the use of plastic and petroleum resin emulsions, sprayed on the surface of soils used for vegetable production, has been conducted at the Central Florida Experiment Station since early in 1959. At first, these materials were viewed primarily as sealants for volatile fumigants in an effort to reduce the cost below that involving sheet polyethylene or vinyl films. They were also used to improve the efficacy of fumigants such as DMTT[3] and SMDC[4]. Normally, escape of the vapors of these chemicals is inhibited only by a water seal or by smoothing the soil with a plank drag to close the larger surface pores. Additional studies with these materials have been directed towards their use for the stabilization of mobile sandy soils, especially where wind and water erosion interfere with successful chemical weed control.

In the early work reported by Darby, et al (1, 2), certain plastic resins, either emulsified or as true aqueous solutions, were used with partial success to confine the vapors of SMDC and DMTT. With some of these materials, they found that the recommended dosages could be reduced 50 percent without loss of effectiveness. After incorporating the fumigant into the soil, the soil was leveled or sprinkled to provide a smooth surface. This aided the formation of a continuous film of the sealant as it was sprayed.

Several problems were encountered during the application of these emulsified plastic and petroleum resins. In the first trials, all of the applications were made using small pneumatic sprayers, inflated either by hand pumping or by use of an air compressor. This equipment was adequate for a few small experimental plots, but was not satisfactory for larger experiments or for commercial treatments. Tractor-mounted sprayers using conventional pumps were used several times, but these proved unsatisfactory. It was felt that many of the application problems encountered must be solved before further progress could be made. Satisfactory commercial application methods must be available if any recommendations are derived from this liquid mulch research program.

The pure plastic and petroleum resins are either solids or heavy sticky viscous materials. For agricultural spraying, they are formulated by adding an appropriate solvent and a suitable surfactant; then they are emulsified in water. The resin particles, comminuted to less than 0.005 inch diameter, are dispersed throughout the aqueous medium. The resulting sprayable emulsions, when freshly prepared, have viscosities close to that of water. In these studies, as long as the preparations remained stable and uniform, they were easily sprayed, but if the emulsions broke, severe application problems developed.

Several factors control the stability of these emulsions. With some formulations, agglomeration of the small suspended particles to form larger unsprayable resin masses may result from settling during storage before use (3). Certain resins also are adversely affected by agitation, beating, or shearing acting in pumps. This produces chemico-physical changes which result in coalescence of the resin particles. Exposure to air in the tank, especially when foaming occurs with by-pass agitation, produces serious agglomeration in some cases. When the emulsions are pumped, particle shearing occurs, and heat is released. This breaks some of the emulsion. As the resin melts, it penetrates the bearings, resulting in binding, further heat production, and eventual "freezing up" of the pump.

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[3]DMTT, 3,5-dimethyltetrahydro-1,3-5, 2H-thiadiazine-2-thione, "Mylone."
[4]SMDC, sodium-N-methyldithiocarbamate, "Vapam."

Equipment Used for Early Mulch Tests

When small hand-operated pneumatic sprayers were used, resin sprays were applied with relative ease provided the following factors were considered:

a. The emulsion was well mixed, and strained before use;
b. The spray tank was clean and free from coagulating agents, such as salts; and
c. Nozzle strainers were removed and nozzle tip size was equivalent to Teejet 8004 or larger.

The first attempts at tractor application met with considerable difficulty. Because of the nature of the resin emulsions, piston pumps were avoided from the beginning. A tractor sprayer, designed for the application of herbicides, was utilized. This equipment consisted of an open tank, a pto-driven rotary pump with 8 nylon rollers (Enparco Model 5467), a line strainer with a 50-mesh screen, and a broadcast boom equipped with Teejet nozzles and size 8004 tips. Excess material from the regulator provided by-pass agitation in the spray tank. Although the emulsion was strained as it was poured into the tank, it was necessary to remove the line strainer screen before the first plot could be sprayed. Nozzle clogging problems soon developed and it was noted that the delivery rate decreased progressively from plot to plot. After treatment of less than 300 lineal feet of row, all pumping action stopped and the pump anchor chain snapped. By this time, the pump was too hot to touch. The emulsion, a plastic polymer resin in water suspension, had been broken and altered by the pump, producing a semi-solid which clogged the whole system. Upon cleaning the host lines, cores of material equal in size to the inside diameter of the hoses extruded. The pump rollers themselves were deformed due to the high temperature and pressure attained (Figure 1).

Better results were obtained with gear pumps, both for plastic resin and petroleum resin emulsions. Even these pumps, however, were short lived. A high quality Oberdorfer pump (Model 9000R) provided less than four hours use. The pump was sent to the factory for examination. It was returned with the report that it was worn and deformed beyond repair since all permissible tolerances for the housing, gears, and shaft were exceeded. This Oberdorfer pump was then replaced with a Hahn Model IE-9072. Molecular shearing was minimized by this pump since it has fewer moving parts and handles a larger volume than the others tested. It gave trouble-free service for several field experimental trials until excessive wear became evident. This was manifested at first by reduced output volume and later by priming difficulties and freezing of the bearings. A complete overhaul was necessary.

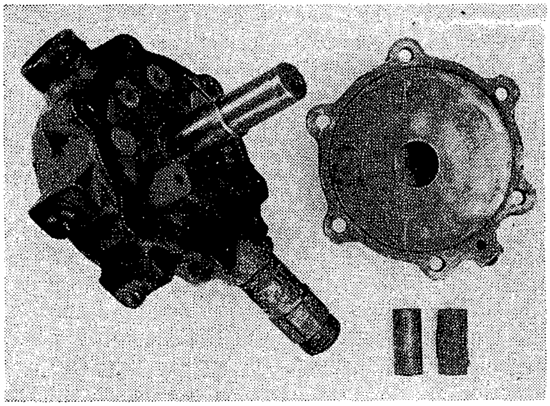

Figure 1. Nylon roller pump disabled by use of plastic resin emulsion. Several of the rollers, including the one at the lower right, were deformed by the heat and pressure.

While attempting to find a satisfactory pump for handling these resin emulsions, other changes were made in the mulch sprayer, improving its performance and dependability. By this time (1962), most of the work with plastic resins was discontinued, and efforts were directed toward the use of petroleum resin emulsions, supplied by Esso Research and Engineering Company, Linden, New Jersey. It was found that a 20-mesh screen, installed in a suction strainer, gave satisfactory nozzle protection provided the emulsions were fresh and the system was clean

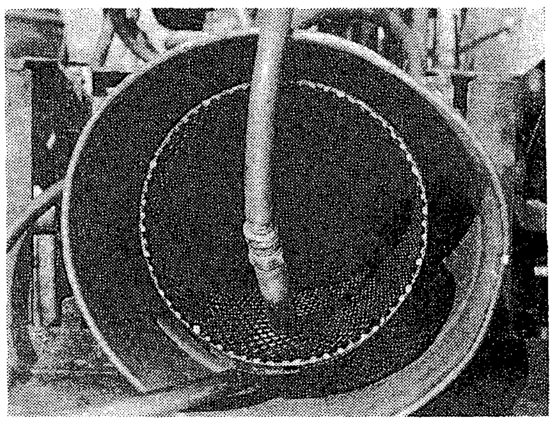

Figure 2. Tank and screen used for continuous straining of petroleum mulch in combination with a gear pump. The suction line is outside the screen and the by-pass line from the regulator empties within it.

at the start. The use of large 8006 and 8008 nozzle tips, depending upon the rate of application desired, was advantageous. A third improvement, suggested by Louis (3), produced the greatest benefit in eliminating clogging problems. Shown in Figure 2, this consisted of a large screen constructed so that it could be inserted within the spray tank. Bronze window screening was formed into a cylinder around a rigid body made from welded expanded metal. The bottom end was also covered. The diameter of the screen was approximately four inches less than that of the tank, a 15 gallon open-end drum. By placing the suction line outside the screen and the by-pass inside, the mulch material was continuously strained as it circulated.

Recent Developments in Mulch Application Equipment

During the winter and early spring of 1963, tractor equipment was developed utilizing air pressure for propelling the petroleum resin emulsion instead of direct pumping as was done previously. The mulch sprayer now used at the Central Florida Experiment Station consists of two main systems, one for compressed air and the other for the liquid resin emulsion. They are mounted together on a sprayer frame fitted to a Ford tractor using a 3-point hitch. To provide stability, the center point of the hitch is secured directly to the tractor without a top link.

Compressed Air System

This system provides a steady flow of air under pressure for propelling the mulch from the spray tank to the nozzles. The pressure is adjustable from 20 to 60 psi and may be accurately maintained within 1 or 2 pounds of the pre-set level. The air system consists of four essential parts, as follows:

a. Compressor (Sears Roebuck & Co. Model No. 15330). (Figure 3). This is a single-piston air compressor capable of delivering 3.0 cubic feet per minute at 40 psi pressure. It is powered by an air-cooled 2.25 horsepower 4-cycle gasoline engine.

b. Air hose line. (Figure 4.) A ¼ inch inside diameter rubber air hose, fitted with standard air line fittings, connects the compressor to the regulator assembly on the tank. A Schrader quick-coupling is used on the tank end of the line to facilitate rapid connections when using the air compressor for this and other equipment.

c. Regulator assembly. (Figure 4.) For pressure control within the systems, a Watts SP-30 diaphragm-type by-pass relief valve and a 60 pound gauge are mounted on top of the spray tank. A small line valve, adjacent to the quick coupling on one side of the assembly, permits preserving the pressure in the tank in case there is need for disconnecting the compressor. A second valve on the opposite side permits bleeding air pressure from the tank when it is necessary to lower the pressure.

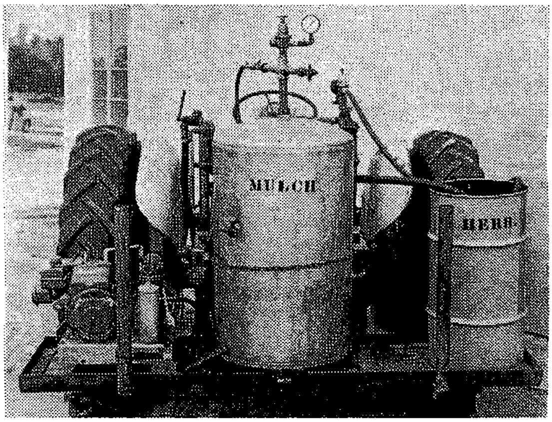

Figure 3. Rear of mulch sprayer showing gasoline-powered air compressor, regulator assembly, and pressure spray tank. Small open drum on the right is used for herbicide spray tank.

d. Tank. (Figure 3.) A galvanized 42-gallon water tank, 20 inches in diameter by 35 inches tall and tested for 160 psi pressure, is used as a spray tank for the mulch. The compressed air exerts constant pressure on the emulsion in the

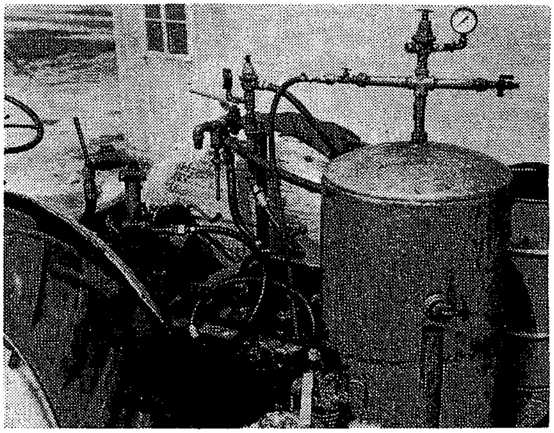

Figure 4. View of valves and hose lines used for both liquid and compressed air systems on mulch sprayer. Boom control valve and line strainer for the mulch are at left. Herbicide control valve and regulator assembly, with hose lines leading to pto gear pump and herbicide spray tank, are at upper center. Air regulator assembly is located on top of the mulch tank.

tank. This pressure is uniform regardless of the amount of air space present above the liquid.

Liquid Mulch System

The liquid system for handling and spraying resin emulsions provides for a minimum of agitation and exposure to air. Except during the process of transfer from the stock or shipping drum, the mulch is kept entirely within a closed system. It is free from any pumping action or other mechanical agitation which could bring about shearing, heating, foaming, or other causes of emulsion breakdown. The main components of this liquid system are:

a. Stock containers. (Figure 5.) Liquid petroleum emulsions are generally received in standard 30 or 55 gallon drums. If the resin particles have settled during storage, the material must be agitated before opening. These shipping drums will safely tolerate a maximum of only 15 psi pressure, so are not satisfactory for use directly as spray tanks.

b. Transfer equipment. (Figure 5.) The regulator assembly from the spray tank is inserted into the small ¾ inch hole of the shipping drum and then coupled with the compressor. An outlet assembly consisting of a drop pipe, valve, and hose adapter, is inserted into the 2 inch drum outlet. A hose from this assembly is held over a funnel placed in the open hole in the top of the spray tank. A double layer of cheesecloth, stretched over the funnel, serves to strain the emulsion as it is transferred. Adjustment of the regulator to give 5 to 7 psi pressure in the shipping drum forces the mulch in a uniform stream onto the cloth. After loading the spray tank, the regulator assembly is replaced on top.

c. Valves. (Figure 3.) On the side of the spray tank are two outlets located 12 inches and 20 inches from the bottom. These are fitted with small quarter-turn valves for use in checking the mulch level inside the tank. The main outlet for the mulch is located on the left side near the bottom. This is fitted with a shut-off valve and a hose adapter to allow removal of the discharge line for cleaning and storage without emptying the tank.

d. Hose lines. (Figure 4.) Neoprene lined rubber hose, ½ inch inside diameter, is used to connect the tank with the line-strainer-control-valve assembly and between this assembly and the boom. Neoprene withstands the effects of the petroleum mulch and also the mineral spirits used as a solvent for cleaning the system. Both hose lines are fitted with hose connectors.

e. Line strainer. (Figure 4.) A Spraying

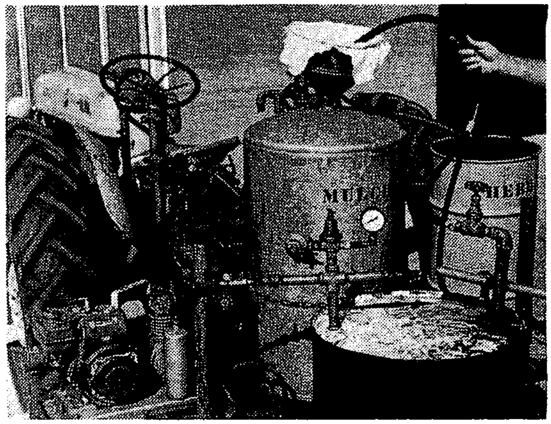

Figure 5. Equipment set up for transferring liquid petroleum mulch from shipping drum to spray tank. The air regulator assembly is moved from the pressure spray tank to the small opening of the shipping drum and a special outlet assembly with a drop pipe leading to the bottom of the drum is inserted into the large opening. Compressed air at 5 to 7 psi forces the liquid mulch on to the straining cloth and into the spray tank.

Systems Model A3/4 ATWB line strainer equipped with a 50 mesh screen is used just before the boom control valve. It has performed satisfactorily with Esso petroleum mulch in this air propulsion system. A quarter-turn valve, mounted at the bottom of the strainer, is opened occasionally during operation. This allows fresh liquid under pressure to flush out any trash trapped by the screen.

f. Boom control valve. (Figure 4.) A quick action ¾ inch full volume gate valve is used for the main boom control. It is mounted within easy reach of the tractor driver.

g. Boom. A section of the boom currently used with this equipment is shown in Figure 6. The boom may be mounted on either the front (Figure 7) or on the rear of the tractor, as desired. It is constructed with ¼ inch standard galvanized pipe fittings and is equipped with a pressure gauge and six drop outlets spaced 12 inches apart. Each drop is controlled by a quarter-turn on-off valve and a Spraying Systems Type ¼AB check valve. The on-off valves facilitate changing from broadcast to band application without changing the booms. Band width and position is controlled by thumb-screw adjustment of the boom brackets. The check valves prevent nozzle drip when the boom is shut off.

h. Nozzles. Either single or double swivel nozzle bodies may be used, but the latter, with the tips directed approximately 15 degrees forward and backward from the vertical, provide better film continuity, especially if the soil is

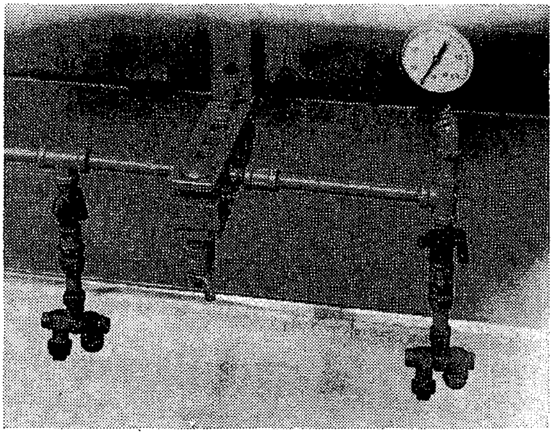

Figure 6. Section of spray boom showing mounting bracket, pressure gauge, quarter-turn valves, check valves, and double-swivel nozzles.

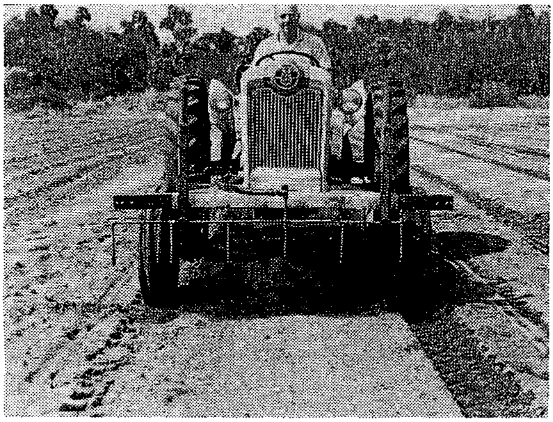

Figure 7. Sprayer operating in field applying petroleum resin emulsion broadcast over a five-foot bed. The nozzle on the left is shut off.

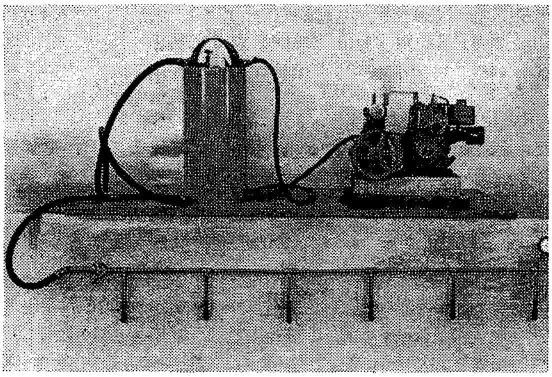

Figure 8. Compressor with 6-gallon tank and portable boom. Quarter-turn valves on each nozzle drop permit application of bands of several widths as well as broadcast treatments.

slightly uneven. Teejet nozzles without internal strainers have proven satisfactory. For petroleum mulch, either 65 or 80 degree nozzle tips may be used, with the orifice size ranging from 02 to 08, depending on the desired delivery rate. Where two tips are used, the maximum orifice size should be 04.

Operation of the Mulch Sprayer

Through adjustment of nozzle tip size, pressure, and tractor speed, any desired mulch delivery rate up to 300 gallons per acre is readily obtained. For still higher application rates, double coverage or speeds lower than one mile per hour are required. Using two teejet 8004 nozzle tips, 30 psi pressure at the tank, and driving the tractor at 2 miles per hour, the delivery rate either broadcast or on a 12-inch band is 100 gallons per acre. Where narrower bands are desired, the boom is lowered closer to the soil and appropriate adjustments are made in nozzle orifice size, pressure, or speed.

This Central Florida Experiment Station sprayer is also equipped for herbicide application. Figures 3 and 4 show much of the herbicide equipment in addition to that for the mulch. An open drum and a pto-driven gear pump used for the herbicide make feasible simultaneous operation of both sprayers. With the herbicide boom mounted on the front and the mulch boom on the rear of the tractor, both treatments may be applied with one pass over the plots (4).

Small pressure tanks with a capacity of approximately six gallons have been adapted for small plot work and for testing different formulations such as those with fungicides or herbicides incorporated into the mulch. Figure 8 shows the air compressor connected directly to one one these tanks. It may be used this way with a portable boom. Usually, however, these tanks are carried on the tractor and are coupled with the compressed air and liquid mulch systems described above. Formulations for several treatments may be loaded in separate tanks which can be exchanged readily while making applications in the field.

Commercial application equipment, involving this combination of air and liquid systems, can be set up easily using an air compressor powered by either the tractor power-take-off or by a small gasoline engine, as done here. All parts are readily available and easily assembled.

SUMMARY

Emulsified plastic and petroleum resins, sprayed on the soil surface as sealants for fumigants or as soil stabilizers to improve herbicide performance, have presented many problems during application. In conventional sprayers with pumps and by-pass agitation, these emulsions often break as a result of shearing, heating, agitation, or foaming. Agglomeration of the resin particles causes clogging of the system. In some cases, penetration of the bearings, overheating, and serious pump damage ensues.

A detailed description is given of a new dual-system sprayer utilizing compressed air as the propellant for the liquid resin emulsions. This sprayer has proven much superior to those involving direct-pumping of the mulch material. The use of a few precautions, including straining the resin emulsion while filling the sprayer tank, effectively eliminates clogging of the hose lines and most nozzle stoppages.

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SALT INTRUSION—DADE COUNTY STYLE

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INTRODUCTION

Since much of Dade County vegetable growing is on land in close proximity to bay salt water and since the many flood control canals and ditches form a close network through the agricultural land before emptying into the bay, salt intrusion is of great economic concern. Even though salt barriers as shown in Figure 1 are located near the mouths of the canals to prevent salt water from entering the canals, high soluble salt levels have been found in the vegetable fields.

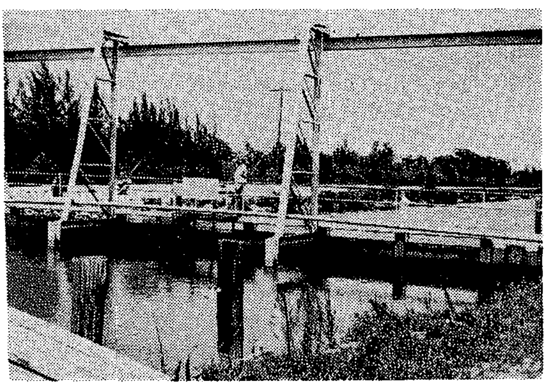

Figure 1. This salt structure prevents salt water from entering the North Canal flood control waterway.

Methods of Salt Intrusion

One of the first methods of salt intrusion that comes to mind is that of surface movement of salt water. A relatively recent example of this method occurred during Hurricane Donna. Much of the coastal marl land was covered by salt water. When this water receded, much of the salt was carried back to the bay by surface water movement. However, a certain amount remained in the soil and possibly leached to some depth. In time this salt will find its way to field water ditches and back to the bay.

Another method of salt intrusion is that of heavy fertilization. A buildup of soluble salts occurs with heavy fertilization, with high analyses fertilizers, under plastic mulches, and with unusually dry seasons. In some cases 3500 pounds per acre of an 4-8-8 will be added to one crop. In many cases the concentration exceeds that which the plant can tolerate as shown by strawberry plants in Figure 2.

Other areas of fertilizer salt intrusion are in our lawns, golf courses, ornamental gardens and in nursery potting soils. Figure 3 shows the result of over-fertilization on a golf course turf. A survey of materials used in potting media has shown high soluble salts, especially potassium, to be present in some sources of peat moss and shavings. When the grower does not know the level of fertilizer salts in such material, he may reach an excess with his normal fertilizer program. The home owner sometimes kills his plants with over fertilization as shown by gloxinia plants in figure 4.