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A Comparison of Chemical Applications Using Micromax Spinners and Conventional Sprayer Tips

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A COMPARISON OF CHEMICAL APPLICATIONS USING
MICROMAX SPINNERS AND CONVENTIONAL
SPRAYER TIPS

A Research Paper
Presented to
The Faculty of the School of Education
Old Dominion University

In Partial Fulfillment
of the Requirements of the Degree
Master of Science in Education

by
John E. Downing

May 1982

This research paper was prepared by Mr. John E. Downing under the direction of Dr. Mildred A. Mason in Vocational and Technical Education 636, Problems in Education. It was submitted to the Graduate Program Director as partial fulfillment of the requirements for the Degree of Master of Science in Education.

Approved by: Mildred A. Mason 4-29-82
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CHAPTER 1

INTRODUCTION

Chemical application may be on the verge of the biggest change since the first spray nozzle spit and sputtered to life some 70 years ago. A new innovation in the dispersion of chemical pesticides, known as Controlled Droplet Application, C.D.A., used rotary atomizers. These rotary atomizers, "spinners", produced droplets of pre-determined, uniform size. Conventional sprayers, using hydraulic pressure nozzles, produced droplets of random size, including many which were much larger than required and others that were too small to control weeds or other pests. The larger droplets contained the greatest portion of the pesticides and either fell to the ground or over killed. The smaller droplets were ineffective and either drifted or evaporated before reaching the target surface. Either way, the gallon usage was high and the cost factor was too great for the farmer to make a profit. Droplets of several hundred microns, a unit of measurement, of chemical droplet size, contained too much chemical for the coverage required or not enough if the droplets were too small and ineffective.

If reliable means could be found of producing uniform drops of pre-determined size and conveying these drops to the spray target with only negligible evaporation, it should then be possible to achieve consistent, effective coverage of targets at extremely low total spray volumes. This savings would result in less time in the field for the farmer equaling less cost to the consumer for the produced goods.

Since the introduction of rotary atomizers in the application of chemical pesticides in 1978, research was limited in its effect on plants. After interviews with local farmers and experimental personnel on chemicals applied and their amounts, the researcher decided to determine the effects of Poast herbicide sprayed on fall weeds and grasses and the

percents of kill by using a conventional hydraulic sprayer and rotary spinners at 2000 R.P.M. and at 5000 R.P.M.

STATEMENT OF THE PROBLEM

The problem of this study was to determine the effects of Poast chemical sprayed on fall grasses and weeds and their percents of kill on test strips by using a conventional hydraulic sprayer with model 8003 tips and by using a C.D.A. micromax spinner at 2000 R.P.M. and at 5000 R.P.M.

RESEARCH GOALS

The basic research goals of this study were as follows:

1. Using the micromax spinners at 2000 R.P.M. or 5000 R.P.M., cut water usage down by $\frac{2}{3}$ and increased coverage of chemical over a total acreage as compared to a conventional hydraulic model 8003 boom sprayer.
2. Using a micromax spinner at 2000 R.P.M. or 5000 R.P.M., a more evenly and controlled droplet size was achieved than by using the conventional hydraulic model 8003 boom sprayer.
3. Use of the micromax spinners at either 2000 R.P.M. or 5000 R.P.M. greatly decreased fill time and less water support equipment was needed to apply chemicals over the same acreage.

BACKGROUND AND SIGNIFICANCE OF STUDY

Controlled droplet application involved the use of centrifugal force generated by a spinning nozzle to produce spray droplets. This permitted greater control over spray droplets size than conventional nozzles; therefore, application efficiency was reportedly improved. To the farmer, this meant improved efficiency meaning that the amounts of water applied per acre could be reduced to three gallons or less and in some cases, chemical application rates could be cut by 50 percent or more.

The reason for developing this research topic was that there existed no substantial evaluative instrument for testing the effects of micromax spinners with herbicides on weeds or fall grasses. A review of literature section indicated that this was true.

The job of any spray nozzle was to distribute chemicals uniformly with a minimum of drift. Conventional nozzles did this by using pressure to break the spray solution into droplets. However, tests showed that those droplets varied widely in size from small ones, which formed a mist and tended to drift away, to large ones which drifted out of control.

In an effort to reduce drift, recent trends have been toward larger droplets and consequently, larger volumes of water. Application rates of 30 to 50 gallons of water per acre were common. While successful in reducing drift, this increased water supply problems requiring large, heavy sprayers and more time for tank filling.

According to McGarvey, President of the company which manufactured the micromax nozzles, "eighty percent of the droplets from a conventional nozzle carry 90 percent of the pesticide solution in most agricultural applications".³ This will mean a loss of chemical from run off or an over kill and will in turn mean a loss to the farmer. "The rotary nozzle breaks up these large droplets, making better use of the chemical in them. A 400-micron droplet can be separated into eight 200-micron droplets or sixty-four 100-micron droplets, so it is easy to see how chemicals can be used more effectively",³ McGarvey.

An early model of the C.D.A. was developed by Edward Bals of Bromyard, England as early as 1953. This hand held version had been marketed in third world countries outside the western hemisphere since then. Only since 1978 has this model reached the United States and over 40,000 have been placed into production.

In August of 1979, Sprayrite Manufacturing Company of Arkansas began controlled field work studies and soon realized the significant contribution that the C.D.A. would have on today's agricultural society. John O. Moore, President of Sprayrite Manufacturing Company stated, "Over the past 35 years, the right equipment had been ignored by research workers but the C.D.A. will change that notion".⁴

LIMITATIONS

The findings and conclusions reached in this study were limited in their applications inasmuch as the results cannot be generalized about all types of herbicides as well as about both spinner speeds. Another consideration in using the C.D.A. spinners was the distance that the spinners were above the intended weeds or grasses. This limitation was based on test results taken during the manufacturing and marketing processes. An 8" to 30" distance was required with a 23.6" optimum height recommended for slow speed usage.

The 40" spacing of each spinner on the boom was another factor that must be duplicated to achieve the same results. A C.D.A. spinner spray pattern was 34" in diameter and formed a hollow cone pattern when positioned horizontally above a flat surface. The spinners were tilted to a 15° angle and the pattern changed to ecliptical shape which did not change appreciable in its pattern width. The drop bracket, which the spinners were attached to, came bent to the specified angle. The researcher's spacings were positioned at 40" centers on a fixed boom that was mounted 24" above the intended kill.

ASSUMPTIONS

The following statements were made:

1. The weather conditions for all test strips were in the same field test plots and they were subjected to the same chemical applications out of the same mixtures per

spinner as the control test strips that had nothing applied to them.

2. The tractor speed and other pertinent information according to the spinner specifications were the same for the 2000 R.P.M. speed as well as the 5000 R.P.M. speed and the model 8003 tips.

3. The percents of kill on each test plot were taken at the same time by a totally objective inspector who did not know which plots had been subjected to the spinners and which ones had been subjected to the model 8003 tips.

PROCEDURES

The procedures that were followed for this study consisted of the following:

1. A need was assessed for more information about the micromax spinners for farmers in the Eastern Shore area and its effects on fall grasses and weeds with no-till planting of soybeans.

2. Significant information was obtained from the Sprayrite Manufacturing Company, from Micron Corporation, from the Virginia Ornamental and Truck Research Station and from interviews with local farmers as well as with local tractor and implement dealerships.

3. Three micromax spinners were installed to drop brackets and attached to a fixed boom and mounted on the back of a Johnson 3pt Hitch Fiberglass Tank Sprayer. This boom was installed in conjunction with the existing boom which held the model 8003 spray tips.

4. Calibration tests were made and all adjustments were made for both booms to be compatible while one was spraying. All hardware and hose connections were checked for any leakage as well as all pressure regulators and hydraulic pumps and PTO connections.

5. Test plots were laid out at the Virginia Ornamental and Truck Research Station in Painter, Virginia under the direction of Dr. Herman Holt and Dr. Henry Wilson.

6. Four test plots were sprayed with the same chemical for each of the different spinner speeds and with the model 8003 tips in use. Four test strips were left as controls or to verify the test results against a given standard.

7. Percents of kill for each spinner and model 8003 tip test strips were taken two and a half weeks later to determine if the spinners had made any significant kill over the model 8003 spray tips.

DEFINITION OF TERMS

1. C.D.A. (Controlled Droplet Application) is a method by which chemicals can be dispersed on a given plot of land or weeds.

2. E.P.A. (Environmental Protection Agency) is a governmental agency established to protect individuals from severe chemical reactions or exposure.

3. G.P.A. (Gallons Per Acre) is a means of measuring the amount of water and chemicals that are applied to a given acre of land.

4. Micron is a unit of measurement. (1 million microns= 1 meter in length which is also equal to 39.37 inches).

5. Model 8003 is a brand type name of sprayer tip that is used on a conventional sprayer driven by an agitator pump.

6. Poast Herbicide is a selective herbicide to be evaluated for post-emergence control of annual and perennial grasses or weeds in soybeans.

7. P.S.I. (Pounds Per Square Inch) is a measurement of force being exerted on a given object.

8. P.T.O. (Power Take Off) is a shaft on the back of the tractor that can generate rotary motion from the tractors internal power motion.

9. R.P.M. (Revolutions Per Minute) is the number of times a spinner or any revolving object spins in 60 seconds.

SUMMARY

Chapter 1 of this research study contained an introduction of the study and why it was undertaken. It included an introduction, a statement of the problem, the goals of the study, the background and significance, its limitations and assumptions, and the methods and procedures followed in conducting this study. Also included was a definition of the terms used and finally an overview and summary of all the chapters contained in the study. In Chapter 2, a review of related research and literature was reported. It included information on history and development of the spinner concept and technical information on field studies and field trials. Chapter 3 contained the research methodology. In Chapter 4 the findings and analysis of the data collected were reported. Chapter 5 contained a summary, conclusions and recommendations of the study.

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CHAPTER 2

REVIEW OF LITERATURE

Application of a chemical mixture was a simple, uncomplicated operation based on applying a certain percentage of chemical over a square inch of target space. The farmer who applied this mixture at the least cost benefited from its action and received the award of higher crop yields and less damage by weeds.

The application of chemical mixtures on crops using some type of spray tip has been around since the brass nozzle was created some 70 odd years ago. Since 1979, United States farmers have experimented with hand held rotary atomizers to distribute droplets of pre-determined and uniform size. The results obtained from these field tests were encouraging so the hand held models gave way to the spinners mounted on pressurized tank sprayers.

HISTORY AND DEVELOPMENT

Hand held controlled droplet applicators, developed by Edward Bals of Bromyard, England, have been marketed since 1953, primarily in third world countries outside the western hemisphere. In 1978, a version of the original hand held C.D.A. was introduced in the United States. This model was developed in the United States by the Sprayrite Manufacturing Company. The initial trial was conducted with rice farmers who, by using one gallon of mixture could spray two miles of crops which would have taken a day and 80 gallons of water.⁹

The Micron Corporation in conjunction with the Sprayrite Manufacturing Company realized that if pest control were a matter of applying a lethal dose of pesticide uniformly over a given target, then the droplet size was the key to effective

control. The micromax spinner, developed by the Micron Corporation created a rotary spray pattern instead of a hydraulic pressure pattern. The key to the effective rotary spray pattern was determined by the correct droplet size for the type of chemical applied and its target.

TECHNICAL INFORMATION

Rotary spinners produced a uniform droplet size as compared to a hydraulic sprayer which emitted droplet sizes ranging from 1 micron to 500 microns or even larger. This wide variation in droplet size caused inefficient application of the chemical. Droplets from a conventional nozzle ranged from very small to very large while a rotary spray nozzle broke the droplets into more uniform size. The droplet sizes were measured in microns. Studies have shown that droplets above 350 microns are ineffective for post-emergence herbicide and insect control as these simply run off leaves. The Micron Corporation micromax nozzle was designed for two speed operations to change droplet sizes. The faster setting generated droplets of 75 to 100 microns while the slower speed emitted droplets of 250 microns.

FIELD TESTING

With the wide ranges of droplet sizes being produced by a hydraulic sprayer, wind drift and wasted chemical applications occurred all too often. "Drift test work at the University of Saskatchewan at Saskatoon revealed that drift from a conventional hydraulic sprayer at 30 P.S.I. was 10 times greater than the micromax nozzle."⁹ Being able to control the droplet size, the researcher was able to control drift of the droplets according to their mass.

The researcher realized that to control the droplet size meant to keep a constant speed and angle of the spinners. This meant that droplets of the same size dropped off the spinner or nozzle the same distance from the point of emission.

Uncontrolled drift was the result of too small droplets. Spray distortion, due to drift, was caused by droplets of varying size. Since the micromax spinners limit droplet size to 250 microns there was less drift. When smaller droplets were utilized the spray pattern shifted downward. However, the uniformity of the pattern was essentially the same.¹⁰

"A study by Akesson indicated the following drift characteristics relative to droplet size in 3 M.P.H. wind when settling from 10 feet.

3 micron size droplets will drift 8 miles
10 micron size droplets will drift 1 mile
15 micron size droplets will drift 2000 feet
100 micron size droplets will drift 50 feet
500 micron size droplets will drift 5 feet."⁹

Two researchers in different locations in the United States completed field studies on the micromax spinners during the summer of 1981 and found them helpful and economical in pest control. Kapusta found that "weed control at carrier volumes as low as 20 to 4 G.P.A. with the rotary nozzle was equal to flat fan nozzles at 20 G.P.A. using either Basagran or Poast."⁸ His study also indicated that less drift was encountered at 10 M.P.H., reduced rates of application using post-emergence chemicals were significant, and spinner spacing was not as critical as they had thought it to be. Jones had similar findings but offered criticism on some minor problems that were encountered.⁷

An appraisal of the controlled droplet applicators was reported in the Soybean Digest:

- "1. Weed control generally had good to excellent results.
2. Water gallonage cut drastically with no performance drop.
3. Though still controversial, chemical rates successfully reduced with some herbicides.
4. Most second-year users still think the rotary atomizer nozzle is a big breakthrough."¹¹

SUMMARY

What began as an experiment for rice farmers using hand held sprayers has now become a popular invention in the chemical application on crops or weeds. Since 1978, over 40,000 rotary atomizers have been placed into production. Two corporations have begun to manufacture spinners for use in converting from hydraulic spray tanks to spinner applications. The investment has been minimal compared to the cost of chemicals being wasted by either drift or run off and over kill.

The information found in the review of literature was very limited since the hand held sprayers were introduced in this country only four years ago. Most of the field work had been completed by independent research stations under the guidance of the two corporations. Chemical companies are now beginning to notice the spinners and the vast differences in chemical mixtures required. Though limited in its availability, the information found in the review of literature helped in the understanding of how a spinner worked and how, under various conditions, the spinner will save money and time to the local farmer.

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CHAPTER 3

METHODS AND PROCEDURES

A reiteration of the three specific goals of this research study follows:

1. Using the micromax spinners at 2000 R.P.M. or 5000 R.P.M., cut water usage down by $\frac{2}{3}$ and increased coverage of chemical over a total acreage as compared to a conventional hydraulic model 8003 boom sprayer.

2. Using a micromax spinner at 2000 R.P.M. or 5000 R.P.M. a more evenly and controlled droplet size was achieved than by using the conventional hydraulic model 8003 boom sprayer.

3. Use of the micromax spinners at either 2000 R.P.M. or 5000 R.P.M. greatly decreased fill time and less water support equipment needed to apply chemicals over the same acreage.

The methods and procedures used in this study were designed to achieve these goals. These include spinner boom construction, sprayer hook-ups, calculations of mixtures of chemicals, and test plot designation.

SPINNER BOOM CONSTRUCTION

A fixed boom assembly was constructed by the researcher to accomodate three micromax spinners mounted horizontally on a Model '890' Johnson Tractor Mounted Sprayer. The researcher chose this model sprayer due to its ease of boom configuration, its large capacity hydro-standard P.T.O. pump and its eight way boom control regulator. The micromax spinner and boom assembly were mounted directly to the sprayer along with the existing spray boom that came with the sprayer. All associated fixtures, electrical hook-ups, and hoses were purchased locally at farm implement stores common to any agricultural area in the United States.

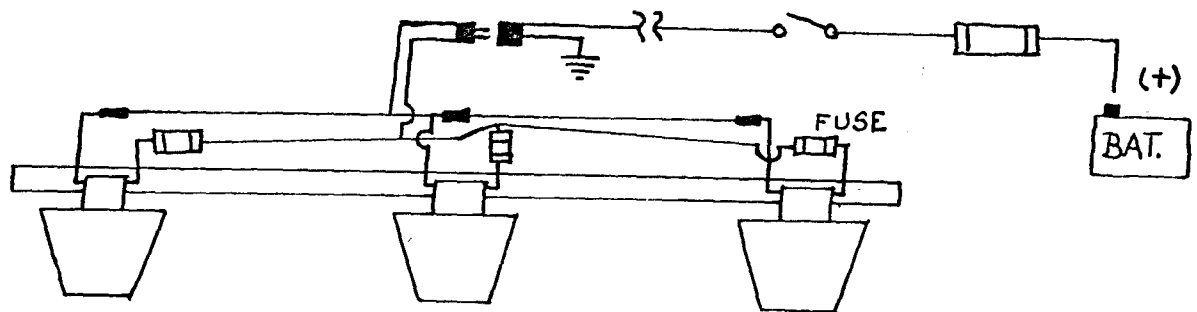
One inch galvanized pipe was used for the fixed boom and the boom extensions. The researcher chose this type and size due to its strength and its resistance to corrosion. Plate metal 1/4" thick and 5" square was welded to each end of the boom extensions using 7014 A.C. welding rods. These metal plates were then primed and painted to prevent corrosion. One end of each boom extension had four holes drilled in the plate to accommodate the 15° spinner drop bracket. The spinner drop bracket was pre-formed to provide the correct angle of spray pattern to the direction of travel and the target. Angling the spinner increased angular velocity, consequently, increasing canopy penetration and coverage. The opposite end of each boom extension had four holes drilled in the steel plate to accommodate a 2 1/2" by 3/8" pipe clamp. All holes were drilled with a 3/8" twist drill bit to allow for 3/8" by 3" machine bolts and washers. The clamps allowed the fixed boom, which was mounted to the tank standards, to hold the boom extensions. Once the boom extensions were positioned for the correct spinner spacings, the boom extensions were welded to the fixed booms by using 7014 A.C. welding rods. This was completed to prevent any vibration of the spinners since boom stability was very important to the correct coverage of the micromax spinners. Small sections of 1/4" channel iron were welded along the fixed boom and the boom extensions to give added strength and support.

Mounting and operation specifications were critical to the smooth performance of the micromax spinners. Some general specifications were:

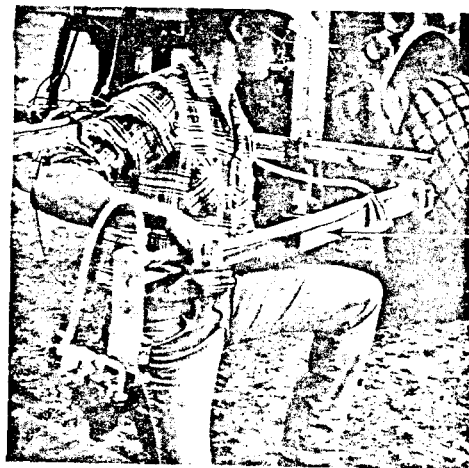
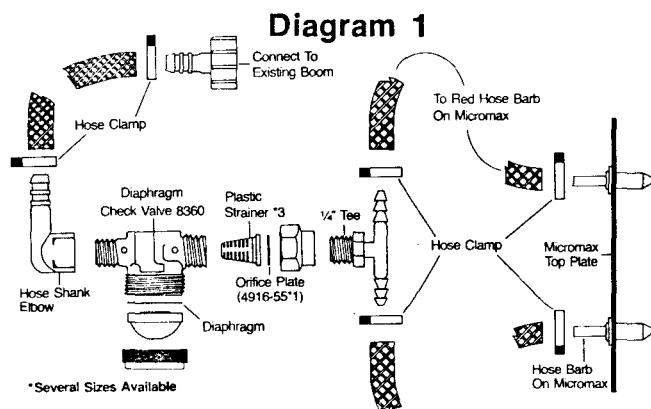
1. Source of power was 12 volts with a 2 amp. power drain.
2. Weight of the spinner was 2.8 pounds.
3. Height and width of each spinner was 5 1/2".
4. Spacing on the fixed boom was 36" to 76".
5. Distance above the targets were 8" to 30" with an optimum height being 23.6" for slow speeds.
6. An orifice disc was used to meter the flow of pesticides.
7. Operation of the spinners at the lowest possible pressures, from 20 P.S.I. to 40 P.S.I.

SPRAYER HOOK-UP

Once the micromax spinners and the booms were attached to the spray tank, the electrical system as well as the feeder hose system were connected. Each spinner operated on a 12 volt D.C. electrical system. The alternator or generator was considered since each spinner has a 2 amp. power drain. Each spinner came with a 5 amp. fuse lead already wired to the motor as well as the positive lead. The three spinners attached to the fixed boom extensions were connected in series to each other and then both positive and ground wires were connected to a disconnect plug. From the other side of the plug the negative or ground wire was connected to the tractor fender so as not to become entangled with the P.T.O. of any hydraulic lifts or drawbars. The positive lead was connected to a larger fuse, 10 amp., to handle the sudden drain and then to a toggle switch which was mounted near the tractor's main control panel. From that point the positive lead was connected to the positive side of the battery by the use of a spring clip. All of the units were grounded in close proximity to the electrical source. Fourteen gauge wire was selected by the researcher for the entire wiring operation since that was large enough to accommodate the system. As illustrated in the picture, the three spinners were wired to a common disconnect plug so the wiring to the power source and the switch could remain on the tractor and the spinners could stay attached to the spray tank.



The feeder hose used to connect each spinner to the eight way boom control regulator was reinforced E.V.A. hose and held in place with worm type clamps. Each spinner came with hoses connecting the diaphragm to the spinner nozzles and enough hose to fasten in the top of each drop bracket. Additional hose elbows and couplings had to be purchased to connect the spinners to the existing hoses going to the 8003 spray tips. The hoses were attached to the boom extensions by the use of plastic tie straps since any disturbance in the spray pattern was vital to the success of the spinners. The diaphragm of each spinner housed the orifice plate which limited the amount of chemical mix entering the spinner. The different sizes supplied with the micromax spinners were designed for the two different speeds of the spinners. All of the hose connections were broken at the closest place to each existing 8003 tip to save on expense of hose and well as having as little obstruction as possible.



CALCULATIONS FOR MIXTURES

Once the spinners were successfully installed on the tank sprayer, the correct calibrations were made to achieve the correct mixtures of chemicals. The calculations used were for the application of Poast herbicide using the micro-max spinners at 5000 R.P.M. and at 2000 R.P.M. and the conventional 8003 tips.

Poast Herbicide at 5000 R.P.M.

A. By collecting the spray given off by running the spinner for 60 seconds and the tractor speed at 1250 R.P.M., the researcher collected 190 milliliters of fluid.

190 milliliters = 6.4 oz. per minute = .05 gal. per minute (GPM)

B. To determine the ground speed using R.P.M. output and the gear ratio, calculations proved to be 4.0 M.P.H. in 4th gear at 1250 R.P.M. according to the tractor specifications. The test tractor for all experiments was a 4000 Ford.

C. To determine gallons per acre (GPA) of total mixture to be applied:

$$\text{GPA} = \frac{5940 \times \text{GPM}}{\text{MPH} \times \text{Nozzle spacing}}$$

$$\text{GPA} = \frac{5940 \times .05}{4.0 \times 39} = \frac{297}{156} = 1.9 \text{ GPA}$$

D. To determine acres covered per load:

$$\text{Acres / Load} = \frac{\text{Tank size}}{\text{GPA}}$$

$$\text{Acres / Load} = \frac{300}{1.9} = 157.9$$

To achieve the correct coverage for the four test strips located at the Research Station in Painter, the researcher calculated the following mixture:

5 pints of oil
8 1/2 gallons of water
5 pints of Poast

Poast Herbicide at 2000 R.P.M.

A. By collecting the spray given off by running the spinner for 60 seconds and the tractor speed at 1250 R.P.M., the researcher collected 420 milliliters of fluid.

420 milliliters = 14.2 oz. per minute = .1109 gal. per minute (GPM)

B. By using the same ratio and ground speed as with the 5000 R.P.M. spinner, the speed will be computed to be 3.8 M.P.H. at 1250 R.P.M.

$$C. \quad GPA = \frac{5940 \times GPM}{3.8 \times \text{Nozzle Spacing}}$$

$$GPA = \frac{5940 \times .1109}{3.8 \times 39} = \frac{658.746}{148.2} = 4.45 \text{ GPA}$$

D. To determine acres covered per load

$$\text{Acres / Load} = \frac{\text{Tank size}}{GPA}$$

$$\text{Acres / Load} = \frac{300}{4.45} = 67.4$$

The researcher prepared new mixture of chemicals inside the spray tank to achieve the original mixture. This mixture consisted of 2 1/2 pints of water, 1/4 pint of Poast and 1/4 pint of oil. Once the correct mixture levels were reached, the researcher added 6.7 gallons of water to the chemical for the expected mixture coverage of 4.45 GPA. This mixture was applied on four test strips at the Ornamental and Truck Research Station in Painter in conjunction with the 5000 R.P.M. spinner mixtures. The test strips were divided into equal spinner widths and lengths so all the applications would be the same.

Poast Herbicide With 8003 Tips

A. Through field testing by the parent manufacturing company on 8003 tips, the gallons per minute (GPM) were not deemed necessary. Conversations with local farmers who used identical spray tanks confirmed this information.

B. The gallons per acre (GPA) for the spray tank and the 8003 tips have also been pre-determined by the manufacturer and the established gallons per acre (GPA) are 25 gallons.

C. The ratio and ground speed using the 8003 tips were slightly adjusted due to the extreme weight carried. The speed of the tractor was adjusted to 4 M.P.H. using 5th gear and the throttle was adjusted to produce 1500 R.P.M.s.

For the researcher to use the existing chemical mixture inside the spray tank 1/2 pint of oil, 1/2 pint of Poast and 7 gallons of water had to be added to achieve the original mixture. The researcher then added 5 pints of oil and enough water to make the total mixture 125 gallons.

THE TEST PLOTS

The 16 test plots were laid out at the Virginia Ornamental Truck and Research Station in Painter, Virginia. This station is one of many such research stations sponsored by Virginia Polytechnic Institute and State University for research in the field of agriculture. Dr. Henry Wilson and staff were very helpful in conducting this study. The strips of land were laid out in random order within the same test plot. Each strip was marked according to the tip used, the R.P.M., the direction of travel and the time of day applied. No two strips of the same chemical were laid out beside each other so as to avoid any over concentration of chemical from drift.

All strips were measured to be the same width which was 15 feet wide and 200 feet long. All chemicals were applied on the same day so the weather conditions were identical with the only difference being the R.P.M.s used and the tips used to have an identical application condition for the field testing. The exact time of day of the applications, the wind direction, the wind speed, and the temperature were all noted on the lay-out drawing of the test plots.

CHAPTER 4

FINDINGS

The researcher, in his comparison of a new product, had to develop a standard by which to judge the effects of the new product over the tested one. The problem of this study was to determine the effects of Poast chemical sprayed on fall grasses and weeds and their percents of kill on test strips by using a conventional hydraulic sprayer with model 8003 tips and by using a C.D.A. micromax spinner at 2000 R.P.M. and at 5000 R.P.M.

DIFFICULTIES

Several difficulties encountered by the researcher were flexibility of hoses, the diaphragm check valve, electrical systems, belt slippage, and boom stability. Once these corrections were made, the spinners performed as safe as possible and as efficient as possible.

The major problem that the researcher had to contend with was the hoses supplied by the Micron Corporation. The researcher had trouble with the flexibility of the hoses and the tightness of the plastic clamps. During the field testing the researcher had to stop the spraying operation to replace a hose that had jarred itself loose from the spinner hose barb. The researcher had to replace several of the spinner hose clamps with worm type hose clamps purchased during the construction of the boom assembly.

The diaphragm check valve which held the orifice plate was the second problem area the researcher had during the field testing procedures. Changing the R.P.M. setting in the field from 2000 R.P.M. to 5000 R.P.M. required the researcher to dismantle the entire hose system assembly to change the orifice plate. This created a problem with down time as well as a loss of chemicals in the hoses.

The electrical system had one problem that was corrected by the researcher. A larger fuse, 10 amp., was placed in the main control panel mounted on the tractor dashboard to withstand the sudden power surge of all three spinners.

A minor problem which the researcher corrected in the field was the problem of belt slippage. A simple adjustment between the motor pulley and the disc pulley eliminated the slippage. The researcher had prior information that belt stretching might be a problem after repeated use but the researcher found that to be untrue during the limited field testing. Belt stretching may be true in a large field operation.

The boom stability was under constant inspection of the researcher since target height and canopy coverage was vital to the success of the problem. The researcher found no significant problem with the boom height or rigidity even when the test strips were laid across rows of soybeans instead of down the rows.

PERCENTS OF KILL

The comparison of kills for each test strip at the research station was made by a field engineer at the local station. The engineer had no prior knowledge of which test strip had been exposed to the model 8003 tips as well as which strips had been exposed to the spinners at either 2000 R.P.M. or at 5000 R.P.M. His inspections were made on the basis of a 10% kill system being a total kill of fall grasses or weeds.

The four test strips marked number 1 on the test strip plot on page 22 of the methods and procedures showed the researcher a 12.0% kill out of a 40% estimated kill. The strips marked number 1 on the plot were the 5000 R.P.M. spinner speed micromax nozzles.

Test strips marked number 2 on the plot were the micromax nozzles using 2000 R.P.M. The field engineer estimated the percents of kill for these four strips to be 38% out of a total kill of 40%.

The field engineer calculated the percents of kill for test strips number 3 and found them to be 36.9% of kill out of a total kill of 40%. These strips were treated using the hydraulic sprayer and the model 8003 spray tips.

All test strips marked number 4 were left untreated as the control strips for visual inspection of the effects of no chemical treatments.

The data chart on page 26 was developed by the field engineer at the Virginia Ornamental and Truck Research Station based on the data collected from the percents of kill of each of the test strips. The remaining data was taken from files on Poast applications of other treatments as well as data to determine the effects of the same chemicals on acres of fields. The engineers conclusion from the data received stated that the 2000 R.P.M. spinners had a higher percentage of kill than the 5000 R.P.M. spinners or the model 8003 tips and the hydraulic tank. There was a significant difference in the coverage between the 2000 R.P.M. spinners and the 5000 R.P.M. spinners but very little difference in kills between the 2000 R.P.M. spinners and the hydraulic tank with the model 8003 tips. From the available data, the 2000 R.P.M. micromax spinner and the model 8003 spray tips would kill the same percentage of fall grasses or weeds but the major difference would be in the water usage.

CHAPTER 5

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

SUMMARY

The purpose of this study was to derive from the problem the comparison of chemical applications using micromax sprayers and conventional hydraulic sprayers and determine if there were any significant differences in kill qualities using the same pesticides. The study determined there was a need for the comparison of the two types of chemical applications and an evaluative instrument was developed in the form of the data sheet to determine the effects of each sprayer and its kill percentage.

The study was limited to test plots at the Virginia Ornamental and Truck Research Station in Painter, Virginia and the construction of the spinners converted to a hydraulic sprayer as outlined in Chapter 3. The study specifically:

1. Examined the need for a comparison study of micromax spinners and hydraulic spray applications.
2. Reviewed all available data concerning cost and time factors associated with the types of pesticide applications.
3. Gathered information concerning micromax sprayers through the review of literature section and used this information to reach the researcher's stated goals.
4. Developed a micromax spinner attachment consisting of three spinners on a fixed boom attached to a conventional sprayer tank to test spray patterns and percents of kill as compared to a conventional hydraulic sprayer.
5. Used the micromax spinners at 2000 R.P.M. or 5000 R.P.M., cut water usage down by $\frac{2}{3}$ and increased coverage of chemical over a total acreage as compared to a conventional hydraulic model 8003 boom sprayer.

6. Used a micromax spinner at 2000 R.P.M. or 5000 R.P.M. and obtained a more evenly and controlled droplet size than that which was achieved by using the conventional hydraulic model 8003 boom sprayer.

CONCLUSIONS

The following conclusions were drawn from a review of related research and literature and an analysis of data collected:

1. There was a definite need for comparisons of percents of kill of micromax spinners and hydraulic sprayers.

2. The total volume of mixture sprayed per acre was considerably less when using the micromax spinners than with the hydraulic sprayers. The total volume of mixture for the 5000 R.P.M. spinners was 1.9 GPA, while the total volume of mixture for the 2000 R.P.M. spinners was 4.45 GPA and the total volume of mixture for the 8003 tips was 25 GPA.

3. The percentages of kill per test strip were slightly higher using the micromax spinners at 2000 R.P.M. than the model 8003 tips. The percentages for the 2000 R.P.M. spinners for the four test strips averaged out to be 38% out of a possible 40% while the model 8003 tips averaged out to be 36.9% out of 40% for the four test strips.

4. There developed a minor problem of belt slippage which occurred several times during the spray operation but was corrected by a tension adjustment.

RECOMMENDATIONS

The following recommendations are the results of observations and conclusions reached by the researcher in conducting this study:

1. Research further the percents of kill using either other chemicals or other spray mediums.

2. The Micron Corporation should redesign the diaphragm housing to include a union fitting. The additional time lost and chemicals wasted to disassemble the hose to change an orifice disc amounted to loss of money.

3. Additional test comparisons on belt driven spinners and a newer hydraulic driven spinner should be considered.

4. Each spinner should be wired to a master control panel mounted on the dashboard to alert the farmer of any malfunction of each spinner. This would eliminate a poor coverage or spotty crop coverage. The researcher sprayed half of one test strip with hoses off of the spinner due to faulty clamps and a control panel would spot any malfunctions.

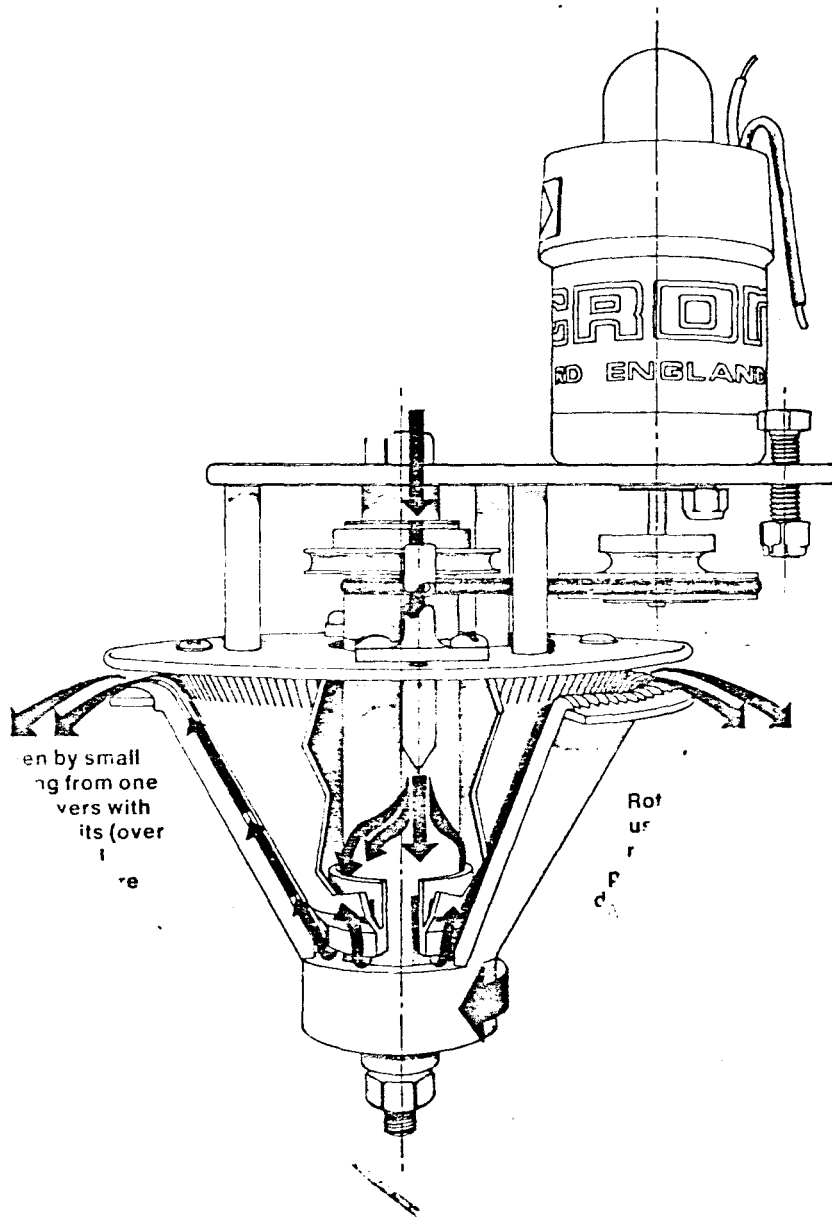
5. A flow meter for each spinner should be a consideration on the control panel to monitor the application rates.

6. After another test period, possibly 1 year, do a follow-up study to determine the effectiveness of micromex spinners using a variety of chemicals and on a variety of crop mediums.

7. Chemical companies begin to label mixtures proportionally to accommodate rotary atomizers as well as conventional hydraulic sprayers.

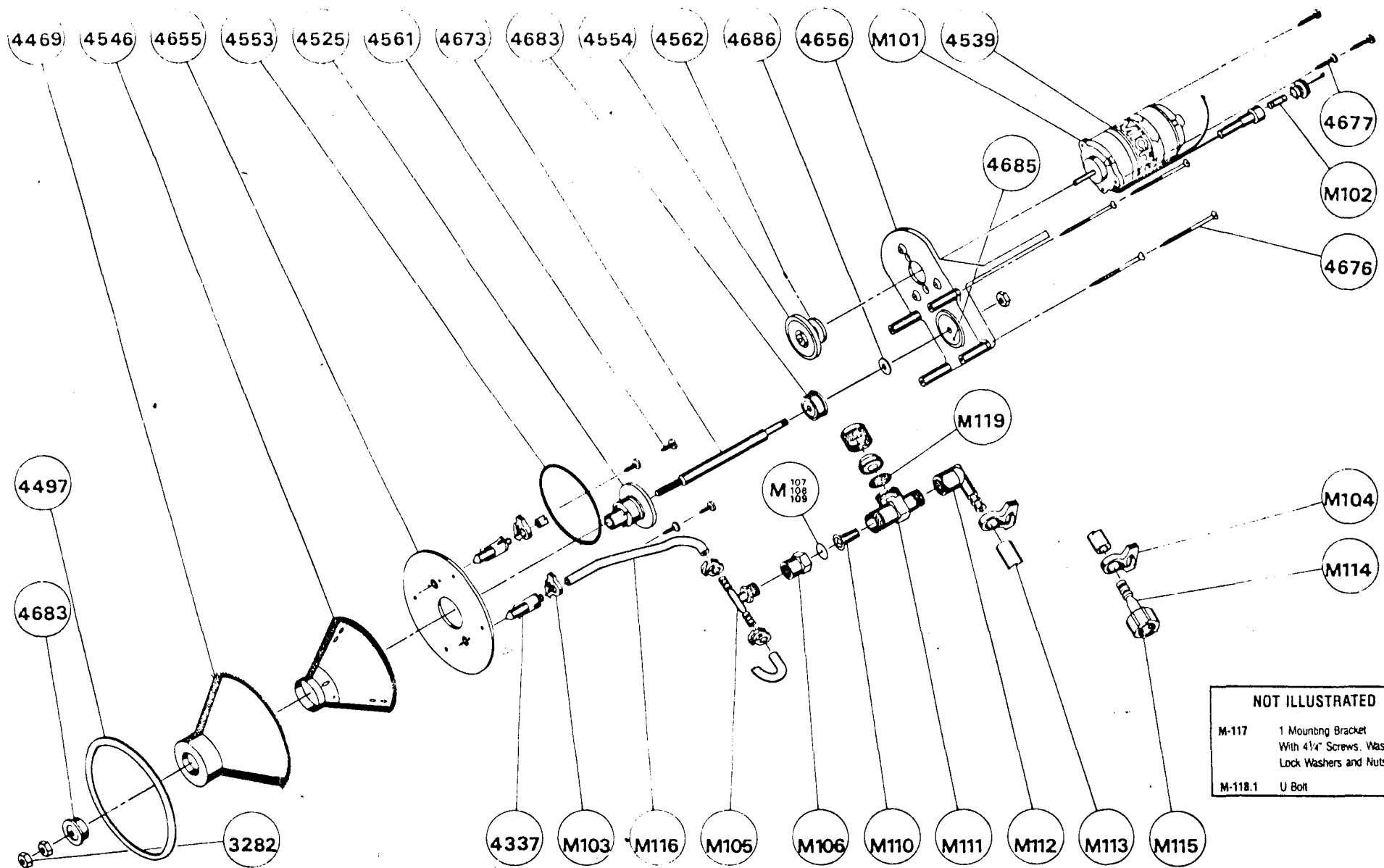
APPENDICES

APPENDIX A
OPERATION PICTURE



APPENDIX B

SCHEMATIC



NOT ILLUSTRATED

M-117 1 Mounting Bracket
With 4 1/4" Screws, Washers,
Lock Washers and Nuts

M-118.1 U Bolt

3282 3 3/8" BSCY Hex Nut
4337 2 Red Hose Barb - 1 6 MM
4469 1 Disc
4497 1 Protection Ring
4525 1 Disc Pulley 2-Speed
4539 1 Label
4546 1 Inner Housing
4553 1 Drive Belt
4554 1 Motor Pulley 2 Speed

4561 4 No. 8 x 3/8" Panhead Screw
4562 1 6 BA x 3 8" Socket Screw
4655 1 Mounting Plate
4673 1 Shaft
4676 4 No. 6 x 2" CSK Screw
4677 3 No. 8 x 1/4" Panhead Screw
4683 2 Flange Bearing
4685 1 Oil Ball Valve

4686 1 Spacer - Flat Washer 3/16"
M101 1 12 volt motor
M102 1 Fuse Connector Set with 5 AMP Fuse
M103 4 1/2" Hose Clamps
M104 2 1 1/8" Hose Clamps
M105 1 Male T Hose Connector 1/4 x 1/4 x 1/4
M106 1 1/4" Outlet Adapter
M107 1 Orifice Plate No. 20
M108 1 Orifice Plate No. 37

M109 1 Orifice Plate No. 55
M110 1 No. 50 Mesh Slotted Strainer
M111 1 Diaphragm Check Valve
M112 1 Hose Shank Connector
M113 1 Hose 3/8" ID 18" long
M114 1 Hose Shank 3/8"
M115 1 Nozzle Cap
M116 2 Hose 1/4" ID 6" long
M119 1 Viton Diaphragm

APPENDIX C
TEST STRIPS

- #1 - Poast - 5000 R.P.M. - 1.9 G.P.A. - Micron Tips - Ground Speed 1200 R.P.M.
- #2 - Poast - 2000 R.P.M. - 4.45 G.P.A. - Micron Tips - Ground Speed 1200 R.P.M.
- #3 - Poast - 4 R.P.M. - 25 G.P.A. - 8003 tips - Ground Speed 1600 R.P.M.
- #4 - Control strips

Weather Conditions: Winds Gusting 12 M.P.H. NE to NW 1:15 PM to 3:10 PM 88° temp.

