A COMPUTERIZED SYSTEM FOR PRECISE APPLICATION OF PESTICIDES IN SMALL PLOTS

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Abstract

Small plot evaluation of pesticides provides critical information for pesticide developers as well as for end users in cotton and other crops. Accurate pesticide placement by spray equipment is becoming increasingly important as is the environmentally proper handling of rinsate or leftover materials following the spray operation. This paper describes a computer controlled spray system which provides optimum precision during pesticide application and provides for environmentally clean handling of rinsate and small amounts of pesticide mixtures remaining in the system following pesticide application. The controller prepares the spray system for loading of the pesticide to be sprayed, and, following initiation by the operator, automatically governs spray, rinse, and system purge operations prior to loading another compound. Manual override is available at any time, and a panic button is available to close all operations in case of an operational emergency. Rinsate is collected in a holding tank for proper disposal following the application of all treatments in a trial.

Introduction

A small plot spray system providing for easy changing of spray solution and rapid, efficient rinsing of the spray-solution container and spray system was described by Reed and Grant (1990). This system controlled spray application and rinse by use of solenoid valves and electric switches and required a number of switch sequences (Table 1) to apply a compound, rinse and flush the system twice, and prepare the system for a replacement compound for the next plot. Under optimum conditions, average plot application time was approximately 1.5 minutes with this system. It was ideal for small plot applications in commercial fields where cleared alleys were absent and plots were arranged along the row, with a randomized treatment being sprayed on each consecutive plot. The system was effective, but the manual operation of the switches became tedious if there were large numbers of plots, and operator fatigue and monotony could induce errors in the rinsing sequence. In addition, the system placed heavy electrical demands on the tractor's electrical system resulting in occasional down time because of battery drainage. A computerized controller utilizing compressed-air actuated ball valves instead of solenoid valves was developed to solve the problems of the previous system and provide for increased precision in all the spray operations.

Materials and Methods

The original small plot spray system as described by Reed and Grant (Fig. 1) was modified only slightly to allow integration of the computerized controller. All solenoid valves were replaced with ball valves (Nupro P4T) and fitted with compressed-air actuators (Nupro MSPTDA). Two additional, hand operated vented valves (Whitey W-1288) were placed four rows apart (two rows to either side of the center of the boom) to allow shunting of fluid into the rinsate tank when only 4 rows are sprayed (Fig. 2) (all valves obtained from Swagelock Co., Solon, OH, 44139).

The ball valves are controlled by computer actuated solenoid valves (MAC Valves, Inc., 30569 Beck Road, Wixom, MI, 48393-7011) which activate the ball valves via compressed air flowing through 1/4 inch (OD) plastic tubing. The MAC valves are controlled via a program in BASIC programming language running on a portable DOS computer communicating with the system through the serial port to a commercial I/O board. Finally, a switch on the control panel now governs the choice between using the 4-row purge valves or the 8-row purge valves eliminating the task of disconnecting and reconnecting the outer purge valves as was necessary with the older system when changing from 4-row to 8-row plots.

A rinsate collection system was also included in the new design which required the use of nozzle bodies with diaphragm check valves (#24230-540-NYB, Spraying systems Co., P.O. Box 7900, Wheaton, IL, 60189) that require a pressure of approximately 7 pounds per square inch to push fluid through the valves to the spray nozzles. The diaphragm valves help prevent spraying while the purge valves are directing fluid to the rinsate collection tank (Fig. 3).

Discussion

Besides providing convenience in operation and increased precision in application and rinsing, the computerized system solved two problems associated with the manual system. Since the Mac valves on the computerized system require only millisecond pulses of electrical current to change the setting of the valves, the demand on the electrical system is negligible, eliminating the previous electrical problems. The other problem related to the electrical solenoids used in the manual system. These

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developed leaky seals, particularly after periods of disuse. Replacing these with air-actuated ball valves should eliminate this problem.

The original design used an a single chip microcontroller coupled to a 2-row, 24 character Liquid Crystal Display (LCD) and a 4-button keypad to set program parameters. A problem with this system prompted us to switch to a PC hosted system using BASIC for our intergface and to communicate to the micro controller via the serial port. The BASIC program accesses the PC's clock to provide timing for the switching sequences, and further controls the MAC valves that operate the ball valves of the tractor's spray system. At initiation of the program, the compressed air valve is turned off, water is turned off, and the spray and purge valves on the boom are turned on to insure a depressurized system. The time allotted for spray, time allotted for rinsing and purging of the system, and the number of rinse cycles may then be set by the operator. Setting of program parameters is menu driven by the BASIC program.

Any portable computer capable of running a BASIC program from DOS might be suitable for operating the system on board the tractor. A small, compact computer with the capability of operating on the tractor's 12 volt electrical system would be ideal. Because of its small size, low cost and built-in applications, the HP200LX computer (Hewlett-Packard Co., 1000 N.E. Circle Blvd., Corvallis, OR 97330), fitted with a water resistant enclosure (Corvalis System Sales, 919 N.E. 2nd Street, Corvalis Oregon) would be appropriate for this use, and work is progressing to adapt the program to this computer. Because the mode of access to the serial port in the HP palmtop differs from typical DOS computers, additional programming is necessary to link the palmtop properly with the I/O board and facilitate control of the MAC valves. When this is accomplished, the palmtop will become a permanent part of the system mounted to the tractor.

The PC system provides great flexibility for adapting the sprayer's operation to different nozzle systems, plot lengths, and rinsing situations (i.e.. flowable formulations which require extra rinsing) since new programs may be written to include situations that were not initially foreseen. This capability to alter programming at will and to add additional features helps provide for future refinement of the spray system. A system which could automatically load the appropriate compounds without manual assistance, leaving the operator only responsible for maintaining tractor speed and insuring that each compound is applied on the correct plot is now possible. A counter could also be added to record the number of plots sprayed during each trial, each test, or each season. If the basic program were also linked to the information for each plot, it could automatically prompt the operator for the proper compound and plot number, giving an additional check to help eliminate application errors. With the BASIC program running in the background, notes on the application of each plot could be kept in another application on the computer, and the possibility of continuously recording temperature and humidity with electronic probes on board the tractor during application is also possible. In addition, one might add sensors on the spray boom and allow the computer to raise and lower the boom in relation to crop height so that boom height would be uniformly maintained for each plot. The system could also be programmed to lower the boom automatically during the rinse cycle to reduce drift to the neighboring plots and to raise it again to the proper height for spraying when rinsing was complete. The system could very easily be adapted to operate the controls of indoor spray chambers, and eliminate tedium while increasing precision.

References

1. Reed, J. T. and R. R. Grant. 1990. An inexpensive device for rapid change, application and rinse of tractor applied chemicals during small plot efficacy trials. Proc. Beltwide Cotton Prod. Research Conf. pp. 262-265.

Table 1. Valve switch sequences used in the prototype and controlled by the computer in the computerized version.

Operation	Air Valve	Spray Valve	Water Valve	Purge Valve
Load Compound	CLOSED	OPEN	CLOSED	OPEN
Spray	OPEN	OPEN	CLOSED	CLOSED
Rinse	CLOSED	OPEN	OPEN	OPEN
Purge line	OPEN	OPEN	CLOSED	OPEN
Purge nozzles	OPEN	OPEN	CLOSED	CLOSED

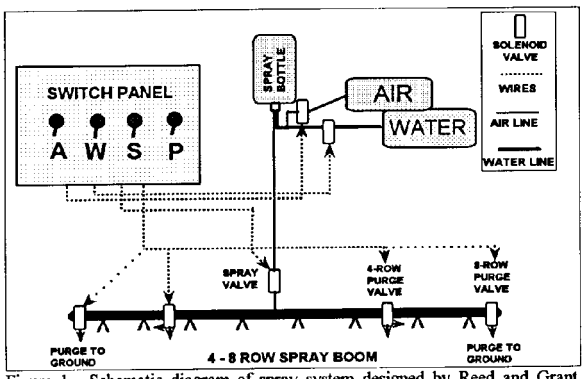

Figure 1. Schematic diagram of spray system designed by Reed and Grant, 1990. Switches in switch panel govern Air, Water, Spray, and Purge valves.

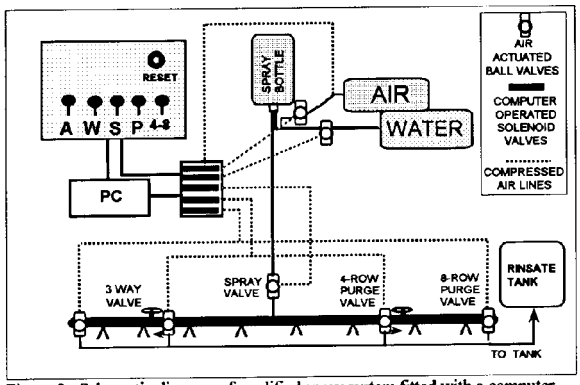

Figure 2. Schematic diagram of modified spray system fitted with a computer (PC), computer controlled solenoid valves, air-actuated ball valves, and a rinsate collection system. Switches in control panel allow manual over-ride of computer programming, and for selection of either 4-row or 8-row purge valves.

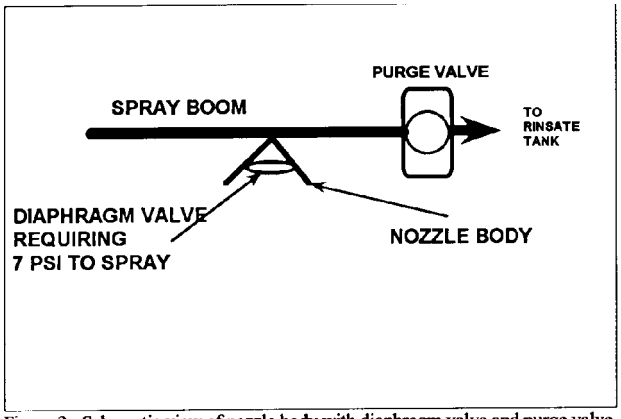

Figure 3. Schematic view of nozzle body with diaphragm valve and purge valve opened to direct rinsate to collection tank. With the purge valve open, pressure in the line is reduced, the diaphragm restricts flow through the nozzles reducing spray and directs fluid to the tank.