USE OF CLOSED INJECTION FOR IN-FURROW APPLICATIONS OF LIQUID FURADAN 4F INSECTICIDE/NEMATICIDE AND DISULFOTON INSECTICIDE ON COTTON

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Abstract

In 1986, FMC pioneered the use of returnable reusable insecticide containers under the trademark, U-Turn. In 1992, FMC introduced the Custom Delivery System (CDS) which allows closed system application of Furadan 4F Insecticide/Nematicide to corn. More recently, a Closed Injection System (CIS) has been developed which utilize injection metering of Furadan 4F and disulfoton into existing in-furrow spray systems. The system allows for simultaneous application of products that provides for early season insect control, seedling protection for Command Herbicide and positive cotton plant effects while reducing container disposal and the potential of worker exposure.

Introduction

In 1986 FMC introduced U-Turn, the first returnable reusable containers for insecticides. When used in conjunction with special measuring and transfer devices, U-Turn containers became an integral part of a closed mixing and loading system utilized by commercial applicators and farmers in many parts of the United States. However, U-Turn containers in many cases were not practical for use by farmers with smaller and more specialized application systems.

In 1992, FMC introduced the Custom Delivery System (CDS) in the Corn Belt as an alternative method of applying Furadan at planting time. Prior to that, in-furrow insecticides had been traditionally applied as dry granular products utilizing planter mounted boxes. CDS was developed to deliver a 50-50 mixture of Furadan 4F and water to liquid in-furrow applicator devices. This was the first system to utilize U-Turn containers with farmer owned and operated application systems. The CDS System is illustrated in Figure 1.

In 1993 FMC received registration for the use of Command 4EC herbicide on cotton. To prevent seedling bleaching from Command it is necessary to accurately apply either disulfoton or phorate insecticides in the seed furrow at planting time. While both insecticides are formulated as dry granules, there has been a distinct shift by farmers to liquid applications. When compared to granular applications, liquid application systems are easier to calibrate and are capable of a more uniform application of the insecticide to the seed furrow. Over the last few years many cotton farmers have utilized in-furrow spray systems to apply liquid fungicides at planting time. These systems have usually been conventional spray systems that utilized tanks, pumps, pressure regulators and spray tips. The spray tips were located in such a manner to deliver a narrow spray pattern to the open seed furrow. This same type system has been utilized to apply liquid disulfoton as a seedling protectant for Command treated cotton. Systems such as this are illustrated in Figure 2. Small plot work conducted by University and FMC researchers demonstrated that a tank mixture of Furadan 4F and disulfoton could be used as a planting time insecticide system. This insecticide mixture provides seedling protection and also results in plant development characteristics similar to those associated with treatments of aldicarb. However, the Furadan plus disulfoton tank mixture treatment did not cause seedling phytotoxicity as observed when either disulfoton or phorate were used in conjunction with aldicarb. Further, the use of the total liquid treatment avoided the calibration and application problems associated with the use of granular insecticides and their applicators. At this point FMC began development of a spray system which integrated existing application systems into a totally closed system that would accurately apply liquid Furadan 4F and disulfoton in the open seed furrow at planting time. The resulting system, shown in Figure 3, utilizes the in-furrow spray system normally used with the above mentioned fungicide treatments and the CDS pump system normally utilized in the application of Furadan 4F to corn. This system has been named, Custom Injection System, or CIS, and is a completely closed transfer, injection and mixing system. It's function is to meter and inject formulated insecticides into the in-furrow spray system. Thus measuring and mixing of the insecticides for the normal tank mixture is eliminated and results in a reduction of worker exposure and time lost during the critical period of cotton planting.

System Description and Operation

There are three key operational functions of this system. First, both Furadan and disulfoton must be metered into the system consistently and at the correct rate. Secondly, the system must be designed and operated in such a manner that a completely homogeneous mixture of the pesticide solution is achieved. Thirdly, the system must be designed and operated in such a manner that the instant the spray system is turned on, the in-furrow spray pattern delivers the required concentration of both Furadan and disulfoton. Errors in the delivery of the correct rate create an unacceptable level of potential plant injury.

The CIS injection pump system consists of U-Turn containers of Furadan and disulfoton, a saddle tank to hold

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the U-Turn containers and rinse water, an injector pump, a controller to regulate and monitor the quantity of product delivered, and two injection and mixer units. The injector pump is actually two separate positive displacement pumps mounted on opposite ends of a variable speed electric motor. The volume pumped is regulated by either the rotational speed of the motor or the angle of deflection of the individual pump heads. The injection and mixer units are inserted into the normal in-furrow spray system ahead of the spray pump.

In operation, the in-furrow spray pump uses the pressure regulator to create a by-pass recirculation loop around the injection sites. The injector pump meters Furadan and disulfoton to the injection sites and the flow of the solution through the mixers insures complete mixing. Thus, when the electric valve of the in-furrow spray system is turned on, the correct insecticide dilutions are delivered immediately. The electric in-furrow spray valve is connected to the CIS monitor to regulate the injection pump thus preventing excessive concentrations of Furadan and disulfoton in the spray system during down periods such as encountered while turning at row ends. This system is illustrated in Figure 3.

System cleanup is easily accomplished by changing valve positions on the CIS pump to inject clear water to flush the entire system.

Performance

The performance of this system must be evaluated from two perspectives, the performance of the injection and spray system and the performance of the products applied.

With the initial problems resolved, the system operated as designed and farmers and dealers were quite pleased. In most cases, the problems were due to air leaks on the suction tubes and difficulties in understanding the functions of the controller and monitor. To correct these problems, changes have been made in the system that will make simplify setup, calibration and operation and should eliminate air leaks.

Insect control provided by Furadan plus disulfoton has met and exceeded expectations. Thrips control under variable infestations and environmental conditions has been equal to that provided by the use of aldicarb alone (Figure 4).

Observations of the effects of insecticide treatments on plant growth and development, earliness, yield and fiber quality provide documentation of the performance of in-furrow insecticides, and define their contributions to cotton production. To obtain information on the effects of disulfoton combined with carbofuran and compared with aldicarb on these parameters, replicated trials were conducted by University and FMC researchers from 1993 through 1995. Large scale commercial trials were also conducted. Treatments consisted of disulfoton (0.75 lb ai/a) in combination with carbofuran (0.5 lb ai/a) applied to cotton treated with clomazone (0.5-1.0 lb ai/a) and fluometuron (.75-1.2 lb ai/a) compared to the standard herbicide program plus aldicarb.

Seedling phytotoxicity ratings taken seven and fourteen days after emergence indicated that disulfoton combined with Furadan resulted in greater seedling chlorosis than aldicarb (Figure 5), although both treatments provided similar plant stands (Figure 6). Observations on seedling growth rates, including plant height (Figure 7) and number of nodes per plant (Figure 8) from 28 after emergence to harvest indicated the insecticide treatments provided similar seedling growth response.

In addition to seedling growth rate, other factors affecting cotton earliness are associated with the plant's ability to produce and sustain fruit. Observations made 42 days after emergence indicated that the node developing the first square was essentially the same for either insecticide treatment (Figure 9). Observations on the nodes above white flower (NAWF) from first bloom (56 days after emergence) to cutout (NAWF-56 to 77 days after emergence) indicated the balance between boll loading and reduction in terminal growth was also similar for both treatments (Figure 10). Open boll observations made from 109 to 124 days after emergence indicate no difference between treatments for crop maturity (Figure 11).

Plant mapping at harvest provides an overview of the plant's effectiveness in establishing, maintaining, and maturing the fruit load and optimizing lint yield and quality. Results of plant maps taken in each treatment indicted that each in-furrow insecticide treatment resulted in essentially the same number of total bolls per plant (Figure 12). The location of the bolls in relation to the main stem effects both yield and quality. Mapping indicated the percentage of bolls on the first fruiting positions were similar for both treatments (Figure 13). However, disulfoton plus carbofuran provided a slight inward shift of the fruiting pattern inward toward the plant's main axis. There were more bolls on the second fruiting positions of sympodia and fewer bolls on the outer sympodial positions and on monopodial branches. Both treatments resulted in similar retention of first position fruit (Figure 14). However, slightly more second position bolls were retained with the disulfoton plus carbofuran treatment. This treatment also increased the retention of early bolls (retention of positions 1 and 2 of sympodia 1-5) in comparison to that obtained with aldicarb. Seed cotton yield was substantially increased with the disulfoton plus carbofuran treatment as compared to the aldicarb treatment (Figure 15). Fiber quality factors including micronaire (Figure 16), strength (Figure 17), and uniformity (Figure 18) were similar for both treatments, although fiber length (Figure 19) was slightly higher with the aldicarb treatment.

In summary, these studies documented the same degree of earliness is provided with in-furrow treatments of disulfoton plus carbofuran or aldicarb. disulfoton plus carbofuran provided increases in optimum fruit positioning, fruit retention and yield while providing similar fiber qualities.

Conclusions

Furadan and disulfoton have been successfully applied to cotton at planting time utilizing direct injection systems. The resulting insect control and plant effects have met or exceeded those provided by competitive treatments. While there were operational problems with the system in the initial year of use, the planned corrections and improvements should make the CIS system a highly desirable tool for handling and applying Furadan 4F and disulfoton as an liquid in-furrow treatment.