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DESIGNING, AND STATIC AND DYNAMIC EVALUATION OF TRACTOR-BACK SPRAYER WITH VARIABLE RATE TECHNOLOGY (VRT)

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Abstract- In recent years, concerns about utilizing various chemical toxicants in different sections of agriculture and also environmental pollutions increased and also convinced researchers and scientists in agricultural sector to discuss and offer new methods related to improve the toxicant management. One of the main disadvantages of increase the use of chemical toxicants in agriculture is transfer chemical materials to food through the soil and cause liver or respiratory cancer. Nowadays, in most countries, spraying fertilizer in farm fields is done without regard to changes in soil toxicant and also need of plant to toxicant and carried out uniformly to all parts of the farm and finally toxicant use and environmental pollution would increase. In developed countries, development of precision farming and using Variable Rate Technology (VRT) is growing rapidly. One of the vital nutrients for plant growth is nitrogen (N). Due to the lack of nitrogen in most agricultural soils, utilizing of nitrogen toxicant in agriculture is more than all other toxicants. On the other hand, excessive consumption of nitrogen would have negative effects on water quality and ecosystem of living organisms. In this paper, designing, construction and evaluation of chemical liquid toxicant spray with Variable Rate Technology (VRT) were carried out and it's used two types of electric valves in Variable Rate Technology (VRT). This technology has an intelligent processor system that spread the toxicant based on soil needs. System performance has been evaluated at different temperature and humidity. Finally, it has been concluded that valve opener have a stepper motor and busted water which have higher performance speed rather than analog gas valve cutter. In addition, humidity and ambient temperature had little effect on the system and toxicant spraying by the system saving $15 per acre and also is useful than traditional methods. By accurate available toxicant at the farm level, it's possible to plenty of products would die and has maximum environmental negative effects.

Keywords: sprayer, Variable rate, Electric valve.

I. Introduction

Economic and environmental issues in addition to technical issues have been forced many agricultural producers to employ new methods in the management of agricultural production. Due to increasing agricultural production with the supply of mineral and organic resources for soils used by plant, therefore, the toxicant was sprayed on the crops in harvesting phase is very important. So, modern and accurate toxicant sprayed would have many benefits. All of its benefits including increase of crops quality, crops performance and also economic benefits for farmers. One of the main disadvantages of increasingthe use of agricultural pesticides and weed removal is that pesticide transfer to food from the soil and cause liver and respiratory cancer. Nowadays, in most countries, fertilizing in farm fields is done without regard to changes in soil fertility and need of plants to the toxins and would carried out for all parts of farm uniformly. Non-normative broadcast of toxicants at the farm level would have negative economic effects and would increase social and environmental concerns. Many of chemical toxicants without being intake by plant would enter into surface water and groundwater and causing toxicity and environmental pollution (6). Philosophy of precise agriculture is that all agricultural inputs such as pesticides and toxicant and etc. that needs to be applied to any part of farm. In this type of agriculture, it is possible to calculate and evaluate differences among smallest possible levels and then different inputs are used based on various types. Variable Rate Technology (VRT) is a management strategy for addressing the spatial variability within the plantation. In other words, VRT is the optimal allocation of production inputs. In conventional methods using toxicants, farm and its products can be considered uniform and for use of toxicants for soil fertility in the farm and the medium for an additional one percent as a safety factor, amount of toxicant per hectare are determined and will be distributed equally in the field. With this method, it's possible to achieve the lowest cost and least environmentally damaging. Mainly, nitrates that are washed from the soil leads into groundwater. Resources that provide exceed of 80% of drinking water for citizens. High levels of nitrogen in lakes would threaten aquaculture. Limit of toxicant spraying to areas with a shortage of farm organic materials could significantly increase the saving amount of toxicant. This approach is in order to optimize the amount of chemical toxicant consumption which led to decrease of cost for farmers and then would lead to increase in product in unit-level, maintain soil structure and increase fertility. Welsh et al. (2002) had used variable rate nitrogen application in the field of wheat and winter barley which their performance is 0.36 and 0.46 per hectare respectively rather than uniform spread of toxicant. Hong et al. (2011) prepared spatial changes of soil fertility factors (K.P.N) function crested wheat using satellite digital images in blocks of 5 for use in variable-rate machines.

These maps show that in total spreading of urea, for maximum performance, only 13 percent of farm receives appropriate toxicant and other farms receive more or less amount of needed nitrogen. While in VRT methods, at least 52 kg per hectare of urea were saved. Paz et al. (2008) showed that level of nitrogen could be reduced, while have more production than uniform performance method. Scientists used this method in corn fields of Iowa State which its average rate was decreased 11 kg/ha than toxicant uniform performance and 15.66 USD per hectare was obtained as benefits. Ulson et al. (2011) constructed an intelligent system of toxicant performance with two neural networks which output of the first consider performance rate equal to satellite maps and also outline of second neural network as a flow rate. The flow rate had been controlled by a Korean valve with electrical sensor. Korean sensor with electrical motor for complete openness (from 10 to 90 degrees) would need to 0.4-1 second. This case was effective in reducing the load of hydraulic system. Besides, the main dimension of this research is the fast response of system. Roger et al. (2011) had applied variable rate in Australian farms and had concluded that would have 15 USD economical savings per hectare. Hong et al. (2011) had used ultrasonic sensor in variable rate system to evaluate latitude and longitude. In fact, the purpose of research was toxicant and toxin spreading on trees and so the had resulted that sensor has a low performance in open area, because by lowering the temperature, the error rate of system would increase, but other factors such as dust, had not significant effect on the system. Zaman et al. (2011) had used variable rate for blueberries and based on various experiments on the plant, they had concluded that plant had a better growth in comparison with traditional method and reduction of toxicant consumption in fertilizing process.

However, based on the importance of issue, it would be necessary to savings, environment conservation and also protection of soils and waters against pollutions. The purpose of this study is designation, construction and evaluation of variable rate toxicant spraying which should be simple and low-cost. Finally, it should be possible to spreading toxicants by this machine.

II. Materials and Methods

For variable rate in system, to type of valves had been designated and constructed. For the first valve, it had been used a combination of stepper motor and busted water. In regards to this issue that stepper motors are under control in any round and angular, they were appropriate for this research rather than direct current motors. For this valve, we had used a 24 (V), 1.5 (A) stepper motor which could endure 12 Kg of forces in 200 (rpm). Connection between circle pin and engine was done by an interface copper metal. Since there is fluctuation probability in Circle- based workflow engine, so by connection of this coupling, this probability takes aside (Figure 1). By receiving necessary voltage and frequency to determine round amount in engine from central control system, stepper started to work and would open and close the valve. This kind of situation changes from open state to close state, would take 3 seconds. In the second valve of a direct current motor with a transmission that is in the range of 90 degrees, one gas valve was built (Figure 2). By reaching the positive 12 voltage signal to the engine, lever connected to the gas valve would positioned clockwise and otherwise would positioned anti- clockwise which lead to the openness or closeness of valve.

Figure 1. First electric valve

Figure 2. Second electronic valve

The used valve in this experiment was selected based on 0.25 inches pump pressure. The designated transmission would enable to changes the valve position just in 4 seconds from openness state to the completely close state. Inlets of two electrical valves were connected through 3 branches connected to the pump outlet (Figure 3). Inlet of pump suction was connected by plastic siphon filter to the tankers and

0.75 inches busted water is put between tankers and siphon to toxicant do not thrown out from tanker when testing and troubleshooting apparatus.

Figure 3. Water pomp and main valves

30 Designation and construction of electronic circuit and its installation on spraying liquid toxicant:

To evaluate flow rate amount and time of passing tractors in the region and total number of openness and closeness of electrical valves, an electrical circuit was designated and written by C program by using a microprocessor. This circuit composed of input, output and central processing unit. First, analyzed data of aerial maps include the needed amount of flow rate in the region and also needed time for passing of tractor from that region was entered to the apparatus by a keyboard. In the system menu, 20 routes were fitted as an arable land zoning. This was done to both tested valves. Processor sector was composed of a programmable microprocessor from RAM family which its task was receiving, storage, analysis and display of data. Since this microprocessor has the latest technology of programmable

processor, its processing speed is high. In order to movement of tractors in farms, it would need to the high speed order to the electrical valve, so this processor had been used. In order to show the route information e.g. passing time of tractor and position of electrical valves, a LCD display was embedded in the circuit (Figure 4).

Figure4. The central controller of apparatus

The input power in circuit would fed from tractor's battery and 12 input voltage from battery of tractor convert to 10 voltage by regulator and also current and voltage of circuit was set up by regulator in the process (Figure 7). In order to prevent noise interference on the tractor and the machine performance, the frame of circuit was selected from a metal around it was covered by aluminum tape. To communicate with the apparatus and receive the information about time and flow rate amount through computer instead of keyboard, input and output of serial was designated for circuit. The particular location is always fixed and not related to changes in soil nitrogen.

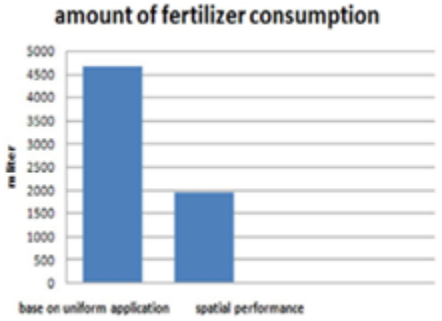

Figure 5: Chart of comparison of average liquid toxicant consumption in different plots based on spatial performance and uniform application

Before entering the apparatus to the farm, it should be calibrate the precise of apparatus, its delay time and its speed. In this regard, evaluation of apparatus was carried out by virtual network on the asphalt in the laboratory and also by real networks in the farm. In this research, the parameters of consumption rate of toxicant location were studied spatially and uniformly. The accuracy and error rates of the machine in any particular area n both laboratory and field tests were evaluated. After testing and data recording, data were analyzed.

III. Results and discussions

Comparison of average liquid toxicant consumption in different plots based on spatial performance and uniform application had been showed in Figure 5.As it's shown in the chart, the amount of consumption toxicant in spatial performance is1949.52 ml and in uniform performance is 4680 ml (based on 4 nozzles and 50 meters movement). This matter means that in spatial performance method, we could have 34.58 percent of saving in toxicant consumption .Diagram of Figure 7 shows comparison of toxicant applied in both ways in every 6 plots.

Increase or decrease of applied amount of toxicant in spatial performance method is depending on needed amount of toxicant in farm from theoretical data. While the amount of toxicant applied

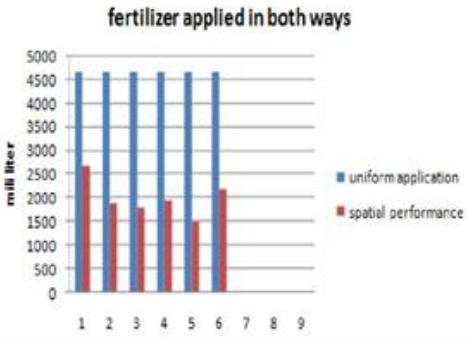

Figure6 . Comparison of fertilizer applied in both ways in every 6 plots.

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