New Mechanized Irrigation Solutions for Small Seed Crops

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Summary

New advances have been made in mechanized irrigation structure and control technologies to meet the specific needs of small seed crops such as carrots, onions and others. Pre-germination, these corps require frequent, light water applications to provide an optimum environment for germination and control wind damage to the seedbed. Post germination, the need changes to a water application which will maintain soil surface moisture to avoid sealing and damage to the individual plants of the emerging high value vegetable crop. In addition control of wind erosion of the soil continues to be important. Previously, mechanized irrigation did not provide a good solution for these specific parameters. This paper will look at the specific needs for this application and discuss new advances created to solve these issues.

Objective

To discuss how modification of the typical center pivot was made to meet specific needs. In addition, a review of changes in control technology allowed for optimum flexibility to meet ongoing irrigation requirements.

Introduction

Mechanized irrigation has been a solution for many grower's irrigation needs for decades. Starting in the 1950's with the first commercially available center pivot and continuing though today, thousands of growers have increased efficiency while lowering operating costs by using this proven technology. One particular crop segment that has not widely adopted center pivots has been the carrot industry. The needs of this carrot crop are such that a standard center pivot is often not up to the task. The primary concern is the need for frequent, light applications immediately after planting to prevent the small, shallow planted seeds from blowing away. The current method for preventing this damage is to utilize aluminum hand-lines placed in the field. Water is rapidly cycled during germination so that any portion of the field may receive water every two and half (2.5) hours. This has traditionally not been an issue in the large carrot production areas as labor has been abundant for the laying out and removing of the irrigation pipe. A typical hi speed quarter (1/4) mile center pivot requires seven hours to make a complete revolution therefore not meeting the two and a half hour requirement. However, the economics of the labor force are putting pressure on the producers who have begun to look at alternatives to decrease labor costs. While center pivots drastically reduces the labor required, they have no been fast enough.

In addition, any leaking from the solid set sprinklers and draining from the sprinkler heads causes considerable crop damage. While the area of damage is relatively small, often only 1 foot in diameter centered around the sprinkler head, multiplied by the hundreds of heads typical for a field, this damage adds up. In addition, the weakened crop in this area is susceptible to disease pressures thus have the potential to harm the entire crop.

Discussion

The challenges of irrigating a small seed crop are many. The seeds are generally planted at a very shallow depth leaving them susceptible to be being blow away by wind. Because of the shallow depth, the soil moisture needed for optimum germination can quickly be lost to evaporation. Irrigating the crop can help with both of these issues but brings its own unique problems. If the irrigation frequency is not rapid enough, the soil will dry out and again be faced with wind issues. If the application rate of the water is too high, you have high potential for washing the seeds out and damaging the seed beds.

In the arid regions of the country where rapid evaporation and wind are a common factor, growers have traditionally utilized solid set sprinklers to irrigate these types of crops. With the ability to change the sprinkler blocks on a fast rotation time, they are able to water each section of the field ever two to three hours. Once the crop stand is established, the run time can be lengthened to provide adequate deep watering.

While effective, this method of irrigation has some drawbacks. The first is the investment in large amounts of irrigation pipe - typically aluminum. As the entire field must be covered in order to provide the needed coverage during germination, a large amount of pipe is needed for the growing operation. As that pipe is set out and picked up for each field, it is very susceptible to damage and must be maintained on a regular basis.

The labor requirement to set out this much pipe, move it for cultivations, and pick it up prior to harvest is also a concern. In addition, with so many valves to be operated during irrigation times, many workers are required to keep the operation moving. As labor has become more and more difficult to source, the labor cost for this type of irrigation has become increasingly more prohibitive.

Additionally, crop damage by any leaks in the sprinkler line can cause additional damage. If flying over a traditional solid set field, one can often see the discoloration of the crop near the sprinkler lines. This is the result of additional water from the leaking joints following the pipelines and leaching the nitrogen and other nutrients below the crops root zone. Sprinklers draining at the end of the irrigation cycle cause similar effects. Besides the issue of crop lost in these areas, the weakened crop is also more vulnerable to disease pressures which can affect the entire crop.

As the labor costs continued to rise, alternative solutions utilizing pivot irrigation were sought. With the main criteria being the need to make a circle in 2.5 hours, the initial thought was to create an ultra-high speed machine. While modern technologies make this approach theoretically possible, several potential issues remained. These include the complexity of the controls needed, the high potential of coasting or rolling ahead of the machine, and the high application rates required.

An alternative to overcome these issues was to look at placing two sets of center pivot spans on one center point. This had been done before in the Columbia basin of Washington State for onions. While effective for germination, it still had some shortcomings. It was not fast enough as the rotation of the pivot is seven hours for a complete circle. Even with the additional spans, this meant any portion of the field is 3.5 hours away from its next irrigation.

Also, this type of configuration did not allow any flexibility in operation. Each side of the machine always operated at 180 degrees from the other. This proved especially inconvenient for field operations such as planting, cultivating and harvest.

For a solution to this need, it was determined to utilize two complete machines affixed to one pivot point. Each side of the machine would have independent operation. To maximize flexibility, each side of the machine has a separate control panel will full programmability options. In addition, a sleeve style valve was installed on each side allowing independent water control.

With two machines operating in the same field, the potential for collision is obviously a concern. To address this, the machines were equipped with three levels of safety. The first is communication between the two control panels. As both panels have position information available, they are not allowed to operate within a set degree of each other. In case this fails, a set of mechanical switches is located on the pivot point again preventing the machines from getting too close. As a last resort, a set of auto stop arms is attached to one machine. If these arms come in contact with the other machine, they are both shut down.

The computer panels also offer the ability to water in different modes. These are independent full circle, independent part circle, or follow-the-leader. With the independent modes, each side of the machine is set to perform its own functions including depth, water statues, auxiliary statues, etc. In follow-the-leader mode, the speed is controlled by the primary machine. The secondary machine is given a distance to follow the first, say 90 degrees, and then adjusts its speed as required to maintain that spacing.

While this addressed some issues, the speed was still not fast enough to meet germination requirements. This was overcome by utilizing high speed center drives with the addition of a variable frequency drive. When the frequency is increased, it is possible to double the speed of the last drive unit. By using this method, the machines have a full rotation time of 5 hours. With the spans directly opposite of each other, any part of the field is at most 2.5 hours from receiving water.

One of the potential benefits to this new machines operation is the ability to apply chemicals in the leading machines. By using the independent full circle mode, the following machine can then water in the chemical. This reduces the amount of time needed to apply chemical in the field. "Growers also feel they are wasting water during traditional chemigation application." (Miller,2006)

Conclusions

With the continued growth in labor cost combined with labor shortages, growers of small seed crops need to find alternatives to current irrigation practices. Center pivots have helped other growers for decades with this very issue but until recently could not meet the demanding needs of these particular crops. With the changes outlined above, center pivots are now ready to meet the unique challenges of small seed crops.

References

Miller, Terry and Miller, 2006, Applying Pesticides for Less, Potato Grower, Volume 35, no 2 Pg 12