USE OF SOLID SET IRRIGATION AT THE CHAMPION CAROLINA NURSERY

John P. Conn, Nursery Supervisor
Champion International Corporation, Carolina Nursery
Swansea, SC 29160

ABSTRACT. Champion International Corporation's Carolina Nursery, located near Swansea, SC, irrigates its seedling crops by means of an above-ground portable irrigation system. This system draws its water from two deep-water wells which have a collective pumping capacity of 1500 gallons per minute. Each well is equipped with a solenoid controlled pressure relief valve which allows the irrigation system to pressurize slowly, helping to prevent blowouts. Underground piping consists of 8, 6 and 3 inch PVC with compression gaskets. This piping is connected so that both wells may be used simultaneously or either one operated individually. Portable above-ground lines are 3 inch x 30 ft aluminum with compression gasketed quick-connect fittings. Manually-operated valve opening elbows are used to attach portable pipe to hydrant valves which are permanently installed at 58 ft intervals along one side of each nursery block. Risers of 1 inch galvanized pipe are attached to the above-ground pipe at 60 ft intervals to support impact-type sprinkler heads.

Above-ground portable lines are moved from one field to another, following the seedling rotation. Cover crops are not normally irrigated at the Carolina Nursery, but, if irrigation is applied, it is done by means of two large irrigation guns. These guns also attach to permanent hydrant valves with manual valve opening elbows and 3 inch aluminum pipe. If electric power to the wells is shut off when irrigation is required, the smaller of the two wells (500 gpm capacity) can still pump water by means of a gear drive which runs off a tractor PTO shaft.

The major advantages of the irrigation system at the Carolina Nursery are that it is versatile, it is easily moved from one field to another and it is relatively simple to repair. The major disadvantages of our existing system are that there are too few underground cutoff valves, the distribution of irrigation water is poor under windy conditions, the risers lack quick disconnect fittings and anti-drip check valves and that changing water from one field to another is too labor intensive and time consuming using the manually-operated valve opening elbows.

GENERAL DESCRIPTION

There are several general categories of non-moving, above-ground irrigation systems which utilize rotating sprinklers. These categories are fully permanent, solid set, semi-permanent and fully portable. The main characteristic distinguishing between these categories is the amount of pipe which is permanently installed by being buried underground. In fully permanent systems, all piping

is buried except the risers which support the individual sprinkler heads. In contrast, a fully portable system generally would have no buried pipe. The irrigation system in use at the Champion International Corporation Carolina Nursery, located near Swansea, S. C., could best be classified as solid set; with all main, branch and compartment header lines buried.

The solid set irrigation system used at the Carolina Nursery draws its water from two deep-water wells. These wells may be used individually or simultaneously to irrigate in any of the 13 fields or blocks comprising the nursery. A collective pumping capacity of 1500 gpm is obtained when both wells are operated at the same time. This amount of water is sufficient to irrigate approximately 8 ac of seedbed at a time. Both wells utilize solenoid-controlled pressure relief valves to allow the irrigation system to pressurize slowly when the pumps are started and which also allow water to be exhausted from the system if water pressure exceeds a pre-determined level. The smaller of the two wells (500 gpm pumping capacity) is equipped with a right angle gear drive which allows water to be pumped by a tractor PTO shaft if electric power is not available.

Main, branch and compartment header lines, consisting mostly of 8-inch and 6-inch diameter compression gasketed PVC pipe, are buried as is characteristic of a solid set system. Compartment header lines are connected to hydrant valves which are permanently installed along one side of each nursery block at 58 ft intervals. Manually-operated valve opening elbows are used to connect hydrant valves to above-ground 3-inch diameter aluminum lateral lines. These lateral lines are made up of sections 30 ft in length which are joined with band and latch type couplings and are moved from field to field following the seedling crop. Compression gaskets at each pipe joint prevent leaking. Risers made of 1-inch diameter galvanized pipe, 18-24 inches tall are installed along the lateral lines every 60 ft. This results in a sprinkler spacing of 58 x 60 ft. Rain Bird® model 14070H full-circle sprinklers are mounted on most risers. When appropriate, Rain Bird® model 35ADJ part-circle sprinklers are substituted for the full-circle sprinklers. Standard nozzles are used in both types of sprinklers. If wet areas develop in a field due to perched water tables, etc., cutoff valves may be installed on individual risers or along the lateral lines so that the rest of the field may be watered while water is withheld from the saturated areas.

SPECIAL USES

Cover crops are not normally irrigated at the Carolina Nursery, but if irrigation is applied it is done by means of two large irrigation guns. These guns are also attached to hydrant valves with valve opening elbows and 3-inch diameter aluminum pipe and each will irrigate an area approximately 200 ft in diameter. The irrigation guns are also used to increase soil moisture prior to fumigation. A 10-acre seed orchard on the nursery porperty is also watered by the solid set irrigation system with sprinklers set up on a 60 x 60 ft spacing. Special overhead pipes are available at each well to allow quick filling of hydromulchers and, in case of emergency, local volunteer fire department tankers.

SCHEDULING

The growing season for bareroot southern pine nurseries may be divided into three general phases, with different irrigation strategies being employed during each portion of the season. The three phases of the season are the germination phase, the rapid growth phase and the dormancy induction phase. During seed germination, irrigation is run frequently to insure that soil at the seedbed surface remains moist. If weather is cool and cloudy during this period, approximately 1/4-1/2 inch of water may be applied every other day to keep beds moist. If weather is warm and dry, however, lighter more frequent irrigation may be needed.

Once seed has germinated fully and seedlings have begun to grow rapidly, irrigation needs are usually determined by tensiometer readings. When tensiometer readings exceed 30 centibars, seedlings are irrigated with enough water to provide adequate seedbed moisture for at least two days. At the Carolina Nursery, about 1/2 inch of irrigation water will usually provide sufficient moisture for this length of time.

As seedlings attain the desired size late in the growing season, irrigation is gradually reduced to promote hardening-off and dormancy. After September, seedlings at out nursery are normally watered about once every two weeks when weather patterns are average. If fall weather is extraordinarily warm, more frequent irrigations may be applied.

Other irrigation schedules may be used at various times during the growing season if special needs arise. For example, if air and soil temperatures become excessive, frequent light irrigations may be applied to cool seedbeds and prevent heat injury to the seedlings. As seedlings become older, however, the need for this type of irrigation is reduced. Another reason to depart from the general guidelines discussed previously would be to slow height growth if seedlings became too tall early in the growing season. In this case, seedlings would be watered only when tensiometer readings exceeded approximately 60 centibars instead of when readings exceeded the normal irrigation level of 30 centibars used during the rapid growth phase.

MAINTENANCE

Routine preventative maintenance of the irrigation system is not difficult, but it is essential if proper performance is to be obtained. Table 1, shown below, lists several key maintenance activities which, if performed regularly, can reduce the occurrence of difficult and expensive major repairs.

Table 1. Preventative maintenance of the irrigation system at the Carolina Nursery.

System Component	Maintenance Activities
Pumps	--Keep pump lubricant tank filled with oil and drip lines open
Motors	--Change bearing lubricants twice each season
Above-ground lines	-Remove sprinklers prior to moving pipe --Store pipe flat when not in use -Remove end plugs when temperatures are below freezing -Change compression gaskets every 3 years
Underground lines	--Drain when temperatures are below freezing

ADVANTAGES AND DISADVANTAGES

The solid set irrigation system used at the Champion Carolina Nursery has both good and bad qualities. Major advantages of this system are that it is versatile, it is easily moved from one field to another and it is relatively simple to repair and maintain. Major disadvantages of the system are that there are too few cutoff valves in the main and branch lines, it is excessively labor intensive to change water from one field to another, the system lacks riser quick-connections and check valves and that the distribution of irrigation water is poor even under fairly low wind conditions. This last disadvantage will be examined more closely in the following discussion.

CASE STUDY: NONUNIFORM IRRIGATION DISTRIBUTION

Dating back to the first seedling crop in 1979, the Carolina Nursery has had problems obtaining uniform distribution of irrigation water, even under relatively calm wind conditions. This poor uniformity was often apparent when alternating areas of light and dark colored (i.e. dry and wet) soil emerged as beds dried following irrigation. In extreme cases, this nonuniform irrigation led to readily observable differences in seedling morphology and bed density. In 1981, Auburn University Southern Forest Nursery Management Cooperative personnel sampled seedlings from wet and dry areas of a single nursery section and found significant differences ($p=.05$) in the number of seedlings/m^2 greater than 3 mm in diameter and in the number of seedlings/m^2 greater than 15 cm in height.

In 1982 and 1983, several attempts were made to improve the distribution of irrigation water which apparently met with some degree of success. Most of the remedies tried involved attempting to increase the area each sprinkler was

covering by increasing water pressure. Additionally, "straightening vanes" were inserted into the range nozzles of many sprinklers. This was also recommended to increase the coverage area of a given sprinkler. In 1985, however, alternating spots of poor germination and seedling growth appeared down the center beds of several nursery sections. The recurrence of this problem indicated that timely rainfall during the 1984 growing season had masked the distribution problem which apparently still existed.

Early in the 1986 growing season, another alternating pattern was detected in the seedbeds. This time seedling color in the center bed of several nursery sections alternated, approximately every 30 ft, from dark to light green. This foliage color difference presumably indicated varying amounts of nutrient leaching due to the uneven distribution of irrigation water. Up to four-fold differences in the amount of water applied per unit of time were detected by placing rain guages in the center beds of several sections at 30-ft intervals.

Since increasing water pressure and using straightening vanes had not solved the problem, the Rain Bird Sprinkler Manufacturing Corporation's catalog of Agriculture Irrigation Equipment (1981) was consulted to determine if the sprinkler spacing used at the Carolina Nursery was correct for the prevailing average wind conditions. The Rain Bird® catalog recommended that for average winds up to 7 mph, the maximum spacing between lateral lines not exceed 65% of the irrigated diameter of the sprinkler and that the maximum distance between sprinklers on a single lateral not exceed 40% of the irrigated diameter. The full-circle sprinklers used at the Carolina Nursery are Rain BirdR model 14070H which are listed as having an irrigated diameter of 111 ft at a nozzle pressure of 75 psi (maximum long-term sustainable pressure for the system). Therefore the distance between laterals should not exceed 72 ft and the distance between sprinklers on a lateral should not exceed 45 ft. Obviously, the 60-ft distance between sprinklers on our lateral lines is in violation of the manufacturer's spacing recommendations.

Checking other sources, it was found that Christiansen (1942) recommended that, for winds up to 5 mph, the maximum one-direction spacing should not exceed 60% of the irrigated diameter of the sprinkler and that the sum of the two spacing distances should not exceed 105% of the irrigated diameter. While our maximum one-direction spacing of 60 ft does satisfy Christiansen's guidelines, the sum of our two spacings, 118 ft, exceeds the recommended 105% of the irrigated diameter.

In view of the spacing guidelines consulted, it appears that a spacing of 45 x 58 ft would give much better distribution. To test this hypothesis, the actual pattern of water coming from a single 14070H sprinkler was mapped under average wind speeds of approximately 5 mph. When this actual distribution pattern was superimposed to scale on a grid of our current spacing distances, dry spots were indeed predicted to occur reasonably close to where they were

actually found in the seedbeds. When the actual sprinkler distribution pattern for 5-mph wind was superimposed to scale on a spacing grid of 45 x 58 ft, it appeared that overall coverage would be improved and that areas receiving no water would be eliminated, regardless of wind direction.

The solid set irrigation system in use at the Champion Carolina Nursery does a reasonably good job of distributing water under dead-calm wind conditions, but if uniformity could be improved for wind speeds of 1-7 mph by reducing the distance between sprinklers, it would be very beneficial to seedling quality, especially in years when rainfall is scarce. Several nursery sections will be converted to the 45 x 58 ft spacing on a trial basis late in the 1986 growing season and irrigation will be conducted as much as possible when wind speeds are less than 7 mph. If this tighter spacing does in fact result in better uniformity of irrigation coverage, it is recommended that the entire nursery be converted to this closer spacing over a period of several years.

LITERATURE CITED

Christiansen, J. E. 1942. Irrigation by sprinkling. California Agricultural Experiment Station Bulletin No. 670.

Rain Bird Sprinkler Manufacturing Corp. 1981. Agriculture irrigation equipment. Rain Bird Sprinkler Manufacturing Corp., Glendora, California. 56 p.