A New Approach to Irrigation

Tom Saunders

Saunders Bros., Inc., 2508 Tye Brook Hwy., Piney River, Virginia 22964

INTRODUCTION

I am changing the title of my talk from a "High Tech Irrigation" to "A New Approach To Irrigation." For those of you who don't know me, I am the production manager of Saunders Bros., Inc., Piney River, Virginia. I have worked in this capacity for the past 15 years, since graduating from Virginia Tech University in the field of ornamental horticulture. Piney River is nestled in the scenic Blue Ridge Mountains in central Virginia between the cities of Lynchburg and Charlottesville. It was the final touchdown site of Hurricane Camille in 1969. Camille (a category 5 hurricane) killed 125 individuals in our county when rainfall fell at a rate believed to be unmatched in recorded history. Rainfall was in excess of 76 cm (30 in.) during a 6-h period. Meteorologists reported approximately 630 million tons of water falling over the county's 471 square miles, which would have the energy value equivalent of a 40,000 megaton nuclear bomb. Incidentally, it was this natural disaster which converted us from being primarily field stock growers to container producers.

In addition to some of the finest Gala and Fuji apples, Saunders Bros. produces peaches, registered Black Angus cattle, and over 1 million plants annually in our 45-acre container nursery. Azaleas, rhododendrons, and boxwood are our specialty; however, we also produce flowering shrubs, hollies, spring annuals, a large line of perennials, dwarf Alberta spruces, and fall pansies.

The Irrigation Person. The most important position in a nursery is that of the irrigation person. Once a pot is filled, it must be irrigated to reduce stress on the transplanted liner plant.

When plant is stepped-up or upcanned, it must be irrigated immediately to reduce transplant shock. Water is crucial during the summer months for evaporative cooling of the plants. In the winter months, prior to a big freeze, the amount of water in the soil system determines whether we will have plants to sell in the coming spring months or not. Through proper irrigation management, we can reduce disease, improve flower bud set on certain crops, and reduce the total amount of fertilizer needed. Now, ask yourself, "Who's watering your plants?" And "Do they really know what they're doing?" The real question is "Can you relax at home if it is 38C (100F) at your nursery with your irrigator making decisions to water?"

When I finished college in 1981, we had a 5-acre nursery and four greenhouses. At the time, we did all the irrigation by hand. Valves were manually opened 24 h per day. Many nights I would leave my wife behind in a cozy bed to open a valve only to return 2 h later to close it and open another. The days of manually opening valves are hopefully long gone for all of us who hope to remain competitive in the nursery industry. These antiquated systems have been replaced with electric solenoids and corresponding control panels designed to irrigate plants for the desired amount of time. Even these newer systems can be greatly improved.

Modernizing our Irrigation System. As our nursery grew from four greenhouses to over 230, we too put in electric solenoids and control panels to facilitate irrigating plants. However, production changes such as direct planting (upcanning) and piece work to increase output created new irrigation obstacles.

Again, we realized our method of irrigation had to change. Initially, I decided to irrigate at night to reduce interference with production activities during the day. Night irrigation improved water efficiency by providing the water at a time when evaporation is lowest. In establishing a schedule, I would run the corresponding number of controllers based on the capacity of the pump. When a controller was to turn off, I would have another programmed to come on. Making this program work was a piece of cake. The problem arose when new plants were potted (which happens often with some of the faster maturing crops such as chrysanthemums, annuals, and perennials) and also when a crop was sold and a large area was emptied and the corresponding zone's time had to be zeroed to stop irrigation. With our multiple cropping areas and crop production periods from 3 weeks to 2 years — the irrigation person has to be on his toes. If you're selling plant material throughout the growing season, these kind of problems happen often. Of course, weather changes and differences in certain media create other changes in our irrigation schedule — sometimes taking hours of calculating.

Computerized Irrigation Scheduling. Knowing the importance of correct irrigation, I sat down with a friend who is a computer programmer. He was able to write a program that has saved me an enormous amount of time in irrigation scheduling.

How does it work? First of all, we try to place all plants that are similar in type, soil mix, and container size in an area that is to be irrigated by a common controller. If possible, different plants would go in an another area irrigated by a different controller. Unlike some nurseries, we grow plants in different container media ranging from 15 to 33% pore space. It is very important to know the production requirements of the different soil mixes being used.

One of the secrets to the whole system is the timer which acts as the clock for the controller. It can be programmed to start and stop up to 4 times a day, which enables us to run both the regular irrigation schedule and a summer cool-down (syringe) with only one program. Unlike most controllers, it doesn't have to start and stop "on the hour."

The Irrigation Controller. A controller box may be able to irrigate or handle up to 12 solenoids (or zones) of plant material. The program allows for a brief description of the controller and allows the person to enable or disable the box (or to run the box or not) simply by inserting a T (for True) or an F (for False). If the plants in an entire area need to be sprayed the controller box can be disabled (cut off) on one day and enabled (cut on) the following. In addition, it has the ability to make multiple replications or provide cyclic irrigation to a zone of plants. This is important in water conservation as well as for plants requiring more time than the controller will allow. For example, if the plants in a given area needs 80 min of water and the box only allows a maximum of 60 min, then two replications can be made of 40 min, or four replications can be made of 20 min each (see Tables 1, 2, and 3).

Table 1. Irrigation controllers.

ID	Description
CONTROLLER: D1	Gray box at injector
ENABLED: T	(True or false)
REPLICATIONS: 2	(1, 2 or 4) = # times to run back to back
PASSES: 1	(1-99) = # times to run all replications with delay between
PRIORITY: 1	(0-99, lower numbers go first)
FLAG:	Cool down: t (true or false)
NOTES: memo	Hold control and press home to open notes window
START TIME	0 minutes since midnight, one pass
END TIME	408
TOTAL TIME	408 minutes with replications, one pass

Table 2. Irrigation controller zones.

ID	Description
CONTROLLER: D1	Gray box at injector
ZONE: 1	1 HH 1-4 hollies
MINUTES:	20 per replication inch/REP
SQUARE FEET:	17472 zone total W 8448S
# SPRINKLERS:	16 square ft/sprinkler:
GPM/SPRINKLER:	4.0 gpm zone total:
INCHES MEASURED:	0.00 In 30 minutes
INCHES PROJECTED:	0.18 in 30 minutes
MINUTES TO .25":	43 minutes
FLAG:	NOTES: Memo hold CTRL and press HOME to open notes window

The Priority Feature. One feature that I particularly like is that the program can be set to prioritize the irrigation of selected areas (see Table 4). The lower numbered boxes run first. This feature enables us to start a controller box at the beginning or end of the schedule depending on the plants within the controller area. If selected plants are more susceptible to disease by staying wet all night, then the box will receive a higher number so that the irrigation section is irrigated later (closer to the end of the night irrigation schedule). In addition, if an area is to be sprayed with pesticides or fungicides and then watered the same day, its priority can be changed to delay irrigation until so desired. This feature is great for plant species that should not stay wet for long periods at night.

Syringing Cycles. A cool-down irrigation cycle (evaporative cooling) is available for each controller box if weather dictates. The cool-down cycle is created by allowing each desired box to make one complete replication. The start time for the cool down is then set to coincide with the hottest part of the day.

Table 3. Irrigation schedule.

Time	Task	Controller description	Total time	Controller on
11:20 AM	ON:	Gray box at injector	6 hr, 48 min	1
11:20 AM	ON:	Lower field	2 hr, 35 min	2
11:20 AM	ON:	Box front of 506		3
11:20 AM	ON:	Box at front of 101		4
11:20 AM	ON:	Box At HH 34		5
11:20 AM	ON:	New area - left box @ rear of		6
11:20 AM	ON:	Green box at injector		7
40 HP	Pump	ON		
1:55 PM	OFF:	Lower field	2 hr, 35 min	6
1:55 PM	ON:	Box wood hollow	2 hr, 14 min	7
2:30 PM	OFF:	New area - left box @ rear of	3 hr, 10 min	6
2:30 PM	ON:	Top hill	1 hr, 04 min	7
3:34 PM	OFF:	Top hill	1 hr, 04 min	6
3:34 PM	ON:	Box at front of 515	1 hr, 52 min	7
3:44 PM	OFF:	Box front of 506	4 hr, 24 min	6
3:44 PM	ON:	Box at front of House 909	3 hr, 00 min	7
4:06 PM	OFF:	Green Box At Injector	4 hr, 46 min	6
4:06 PM	ON:	Rhododendron terrace	1 hr, 42 min	7
4:09 PM	OFF:	Boxwood hollow	2 hr, 14 min	6
4:09 PM	ON:	New area lower - right box @ r	2 hr, 30 min	7
4:28 PM	OFF:	Box at HH 34	5 hr, 08 min	6
4:28 PM	ON:	Box at back of house 909	3 hr, 02 min	7
5:26 PM	OFF:	Box at front of 515	1 hr, 52 min	6
5:48 PM	OFF:	Rhododendron terrace	1 hr, 42 min	5
6:08 PM	OFF:	Gray box at injector	6 hr, 48 min	4
6:39 PM	OFF:	New area lower - right box @ r	2 hr, 30 min	3
6:44 PM	OFF:	Box at front of house 99	3 hr, 00 min	2
40 HP Pump	OFF			
10 HP Pump	ON			
6:48 PM	OFF:	Box at Front of 101	7 hr, 28 min	1
7:30 PM	OFF:	Box at back of house 909	3 hr, 02 min	0
10 HP Pump	OFF			

Schedule start = 11:20 AM
Schedule end = 7:30 PM
Total schedule time = 8 hr, 10 min

Zone File. The next file is the "zone file." This is really a working file where all solenoid zones are listed within a controller box. In a particular zone, we enter the number of minutes we want to irrigate the area. We also enter the square feet within that zone for the summer and winter irrigation periods. Most of our houses are built so growing can take place in the greenhouse middles, and then we jam the houses can-tight as our overwintering process begins. Consequently when the houses are covered for winter, the sprinklers are irrigating a smaller area than in the summer. The irrigation time is reduced to apply water to the reduced square footage.

Calculating Vertical Inches of Irrigation Water. In each zone, we also list the total number of sprinkler heads and the flow rate of gallons per minute (gpm) for the particular sprinkler head. We then determine square feet per sprinkler, total gpm in the zone, total gallons of water applied per zone, and most importantly — the amount of water applied in vertical inches. This latter figure is the one I use most when determining the amount of water to apply in a particular zone. Because our nursery was built over a period of 15 years, our houses are not a standard size, nor are the middles a standard width. This variance makes the amount of water applied in vertical inches that much more important because it allows the comparison of zones using a similar format. In other words, a house that has middles up to 3.7 m (12 ft) will require 25% more water than will a house that has a 1.8-m (6-ft) middle (assuming uniform house widths).

The Task File. The task file helps generate the irrigation schedule. This schedule tells what time our irrigation schedule starts and ends, and the time each controller is on and off. It reports the total amount of time a particular controller is on. It helps the irrigation person know what time a particular irrigation pump(s) needs to be on, and when they should be shut off.

The Change Settings File. A second task is the change settings file that allows us to set a particular schedule start time and cool-down start time. This enables us to spray pesticides in the evening after work, and change the irrigation time to accommodate it. It also allows us to facilitate turning irrigation pumps on and off.

Because most control panels will not let you irrigate longer than 60 min, we can set this parameter in the task file. Finally, once we determine a pump's irrigation capacity, we enter that number so irrigation pressure will not be a problem. With this number entered, only the corresponding number of controllers will run, based on the priority of the particular controller. Once a controller has run for the total amount of time desired, the next highest priority controller number will come on to fulfill the pump capacity.

Printout Reports. Once a schedule has been printed, the report is followed by the irrigation person in setting the amount of time to irrigate each particular zone. Using the printed report, all controller boxes can be set to accommodate planned field work. Furthermore, a hard copy is available which gives data on total gallons of water applied during the schedule, and the amount of water applied per zone in vertical inches. From a managerial standpoint, it is this later figure which is most important.

Table 4. Irrigation controllers and zones.

A. Lower field (11:20 AM - 1:55 PM) priority = 2

1 repl.	Min/repl	Zone#	Description	Vertical in. of water	Gallons of water
	18	1	T terrace 1 gal azaleas	0.21	1152
	22	2	A terrace various, far end	0.21	1408
	10	3	L7 & L8 houses boxwoods 1G	0.11	640
	10	4	L5 & L6 houses boxwoods 1G	0.10	640
	40	5	L3 & L4 Houses Junip.& Spruce	0.31	2880
	40	6	L1 & L2 Leyland cypress	0.28	1600
	15	7	Poplar tree & L. Main (P. Shed)	******	0

Total time per replication = 2 h, 35 min

Total gal = 8320

Total time with replications = 2 h, 35 min

B. Boxwood hollow (1:55 PM - 4:09 PM) priority = 8

1 repl. Min/repl	Zone#	Description	Vertical in. of water	Gallons of water
16	1	301-303, 201 - (Propagation)	0.21	832
16	2	202-204	0.17	768
16	3	205-207	0.18	768
16	4	304-306	0.18	768
16	5	307-309	0.20	768
18	6	New area top	******	1584
18	7	New area middle	******	1728
18	8	New area bottom	******	1368

Total time per replication = 2 h, 14 min — Total gals = 8584
Total time with replication = 2 h, 14 min

C. Top hill (2:30 PM - 3:34 PM) priority = 9

1 repl. Min/repl	Zone#	Description	Vertical in. of water	Gallons of water
0	1	Gravel terrace @ pack shed	******	0
16	2	Behind reserv. & Below prop.	******	832
16	3	Top hill facing pack shed	******	1408
16	4	Top hill - field rd. - Hemlock	******	896
0	5	Field rd. Near hollow	******	0
16	6	Propagation areas	******	1024

Total time per replication = 1 hr, 04 min — Total gals = 4160
Total time with replications = 1 hr, 04 min

D1 - Gray box at injector (11:20 am - 6:08 PM) priority = 1

1 repl.	Min/repl	Zone#	Description	Vertical in. of water	Gallons of water
	20	1	HH 1-4 hollies	0.24	2560
	18	2	HH 5-7 hollies	0.28	2304
	30	3	HH 8, 10, 12, 14, azaleas 3G	0.36	3840
	30	4	9, 11, 13, azaleas 3G	0.36	2880
	20	5	HH 14A-14D azaleas 3G	0.33	2560
	28	6	HH 15-18 azaleas 3G	0.34	3584
	28	7	HH 19-21 azaleas 3G	0.34	2688
	20	8	21A-21D azaleas 3G	0.33	2560
	10	9	27A-27D azaleas 3G	0.33	1600
					Total gals = 24576

Total time per replication = 1 hr, 04 min
Total time with replications = 6 hr, 48 min

D2 - Green box at injector (11:20 AM - 4:06 PM) priority = 7

1 repl.	Min/repl	Zone#	Description	Vertical in. of water	Gallons of water
	8	1	Y terrace	******	0
	15	2	Z terrace azaleas 1G & can hems	******	2160
	12	3	AA near	0.23	1536
	12	4	AA far	0.22	1536
	24	5	BB lower	0.48	3264

CONCLUSION

In summary, this system has saved our nursery valuable management time — some days up to 3 to 4 h. It also has earned us money by reducing fertilizer usage by 33% on selected crops. It provides a management tool to oversee that the irrigation person is providing the amount of water experience has taught me to give the plants. A plus over other systems is that this one doesn't require any additional wiring. It allows flexibility in setting start and/or stop times. It has the flexibility to quickly increase or decrease irrigation times, depending on weather conditions. This systems eliminates the need for years of experience generally needed of a field employee to carry out the irrigation planned. However, the system maintains enough hands-on operational requirements to catch mistakes. Finally, it allows me extra time to do other important things.