Irrigation Setup and Reducing Water Use

Chris Rolfe
NSW Agriculture, Wollongbar Agricultural Insitute, WOLLONGBAR NSW 2477

To grow a quality plant in the shortest time in a given climate, the water and air content of the potting mix should be in balance and adequate fertiliser should be available throughout the crop cycle. Supplying the right amount of water at the right time to all plants in a production area is the key. This requires an irrigation system that applies water evenly and a control system that allows the required flexibility to match climatic and crop variations.

How does your system measure up? For fixed overhead sprinkler systems, which are still the most popular system in the industry, there are irrigation standards that you can calculate for each block.

Your irrigation system should have:

- Mean application rate — less than 15 mm per hour
- Coefficient of uniformity of sprinklers — more than 85%
- Scheduling coefficient of application — less than 1.5

What is the significance of these measurements? Well let's take them one at a time.

If you apply water at less than 15 mm h^{-1} then it is likely that the application rate will be slow enough for the potting mix to absorb the water as it is applied. This means that when the water starts draining from the bottom of the container, the moisture content of the mix is at its optimum. This can then be a useful guide to irrigation timing.

If the coefficient of uniformity of the sprinklers is above 85% (and the application rate is below 15 mm h^{-1}) then you probably have sprinklers well suited to the spacing you have selected and operating at a pressure that provides a range of droplet sizes.

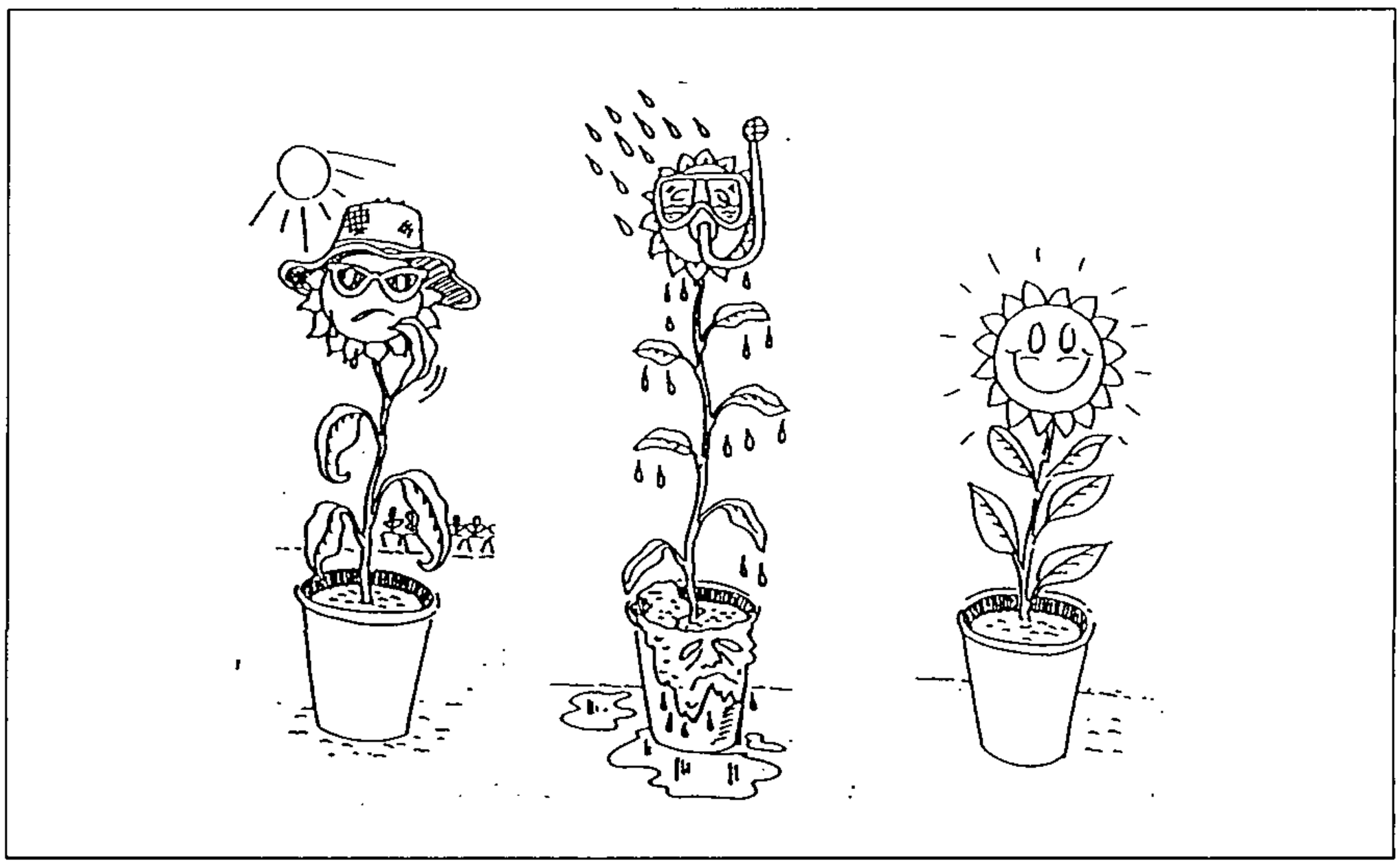

Figure 1. Uneven water application effects plant growth.

A scheduling coefficient of less than 1.5 will indicate that the location of the sprinklers in relationship to the containers being watered allows each container to receive water from 3 or 4 sprinklers. This means that to apply sufficient water to the driest container in the block the containers that are in the middle range receive less than 50% more water. This will minimise excessive leaching.

Apart from wasting water the work done by Cresswell and Huett (1996) suggests the higher the leaching volume, the higher the fertiliser volume in the drain. They found that under a typical summer irrigation level of 25 mm a day, up to 40% of the nutrients in controlled-release fertilisers were being wasted over 10 weeks. This of course has an effect on plant growth.

WHAT PERCENTAGE OF YOUR PLANTS FIT IN THE CATEGORIES SHOWN IN FIGURE 1

Uneven water will result in overwatering, excessive leaching, and uneven plant growth. This results in a higher percentage of throwaways and additional time at dispatch in selecting plants from the production area that are suitable for the order (about 8 cents/150-mm container)

How much does uneven watering cost you in lost production, dispatch cost, and water cost?

Much of the details of how to evaluate your irrigation system is covered in the *Waterwork Manual* used in the Waterwork workshops that are run nationally in the industry.

For now let's just look at one aspect that you can do on your nursery when you go home. What is a scheduling coefficient, how do I calculate it and what does it tell me about my system?

Most nursery operators will water a block of plants for long enough to put sufficient water in the driest pots which are usually located along the edges and ends of the blocks. The scheduling coefficient (Sc for short) is a measure of how much extra water you are putting on the majority of your plants to wet up the driest pots.

$$\text{Scheduling coefficient} = \frac{\text{average application rate}}{\text{driest pot application rate}}$$

To illustrate what this might tell you about your system, let's take a couple of common nursery layouts and check them out (Figures 2 and 3).

If these layouts are equipped with well designed irrigation systems with sprinklers operating at the correct pressure to provide a high coefficient of uniformity and an application rate of less than 15 mm h^{-1}, the scheduling coefficient, the edges, and ends of each layout will have significantly lower application rates than the middle areas. This can be best illustrated in the production bed area. This bed can be divided into three zones (Figure 4).

The scheduling coefficient to provide adequate water to zone C is 3.3. This means that 92% of the area is being overwatered to meet Zone C's requirement. Many operators will overcome this by hand watering which is an inefficient and expensive option.

The benches aren't quite as bad but the scheduling coefficient here will be 2.2 to meet the water requirements of the ends and edges which still overwaters most of the bench.

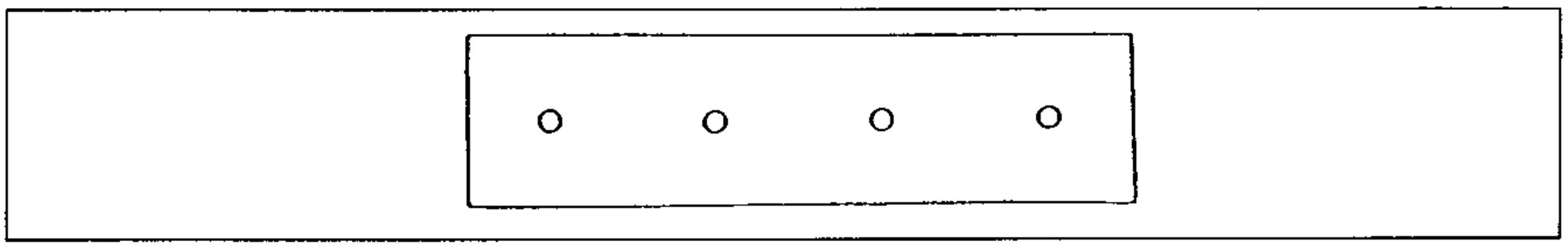

Figure 2. Common arrangement of sprinklers on benches.

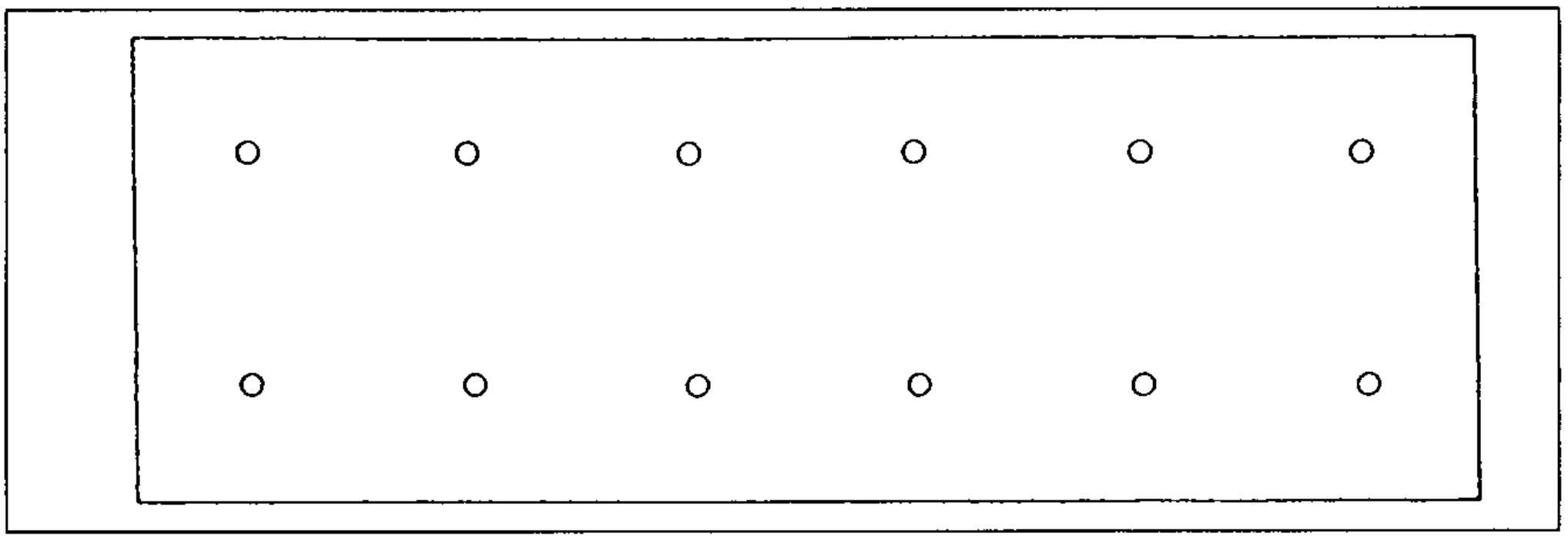

Figure 3. Typical arrangement of sprinklers on production beds.

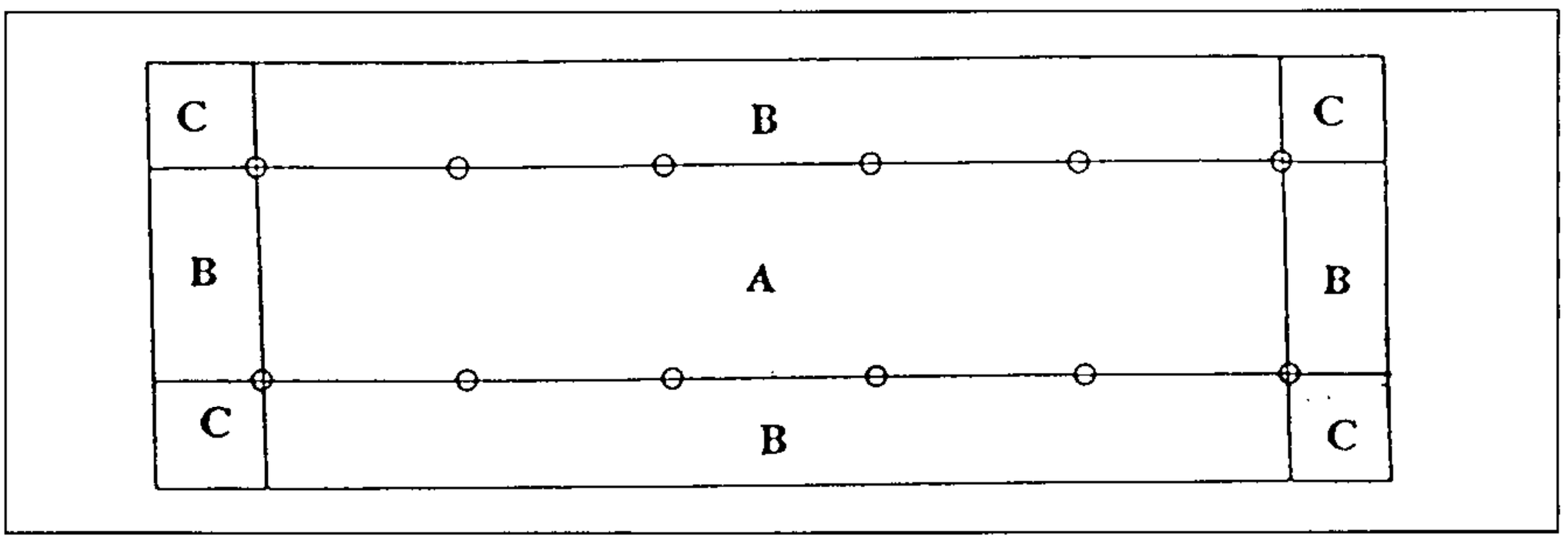

Figure 4. Zones within production area. Zone A - receives water from 4 sprinklers representing 42% of the area, Zone B - receives water from 2 sprinklers representing 50% of the area, and Zone C - receives water from 1 sprinkler representing 8% of the area.

The key to reducing the scheduling coefficient and hence the overwatering problem is to reposition the sprinklers so that each container receives water from four sprinklers so the layouts now look like those in Figures 5 and 6.

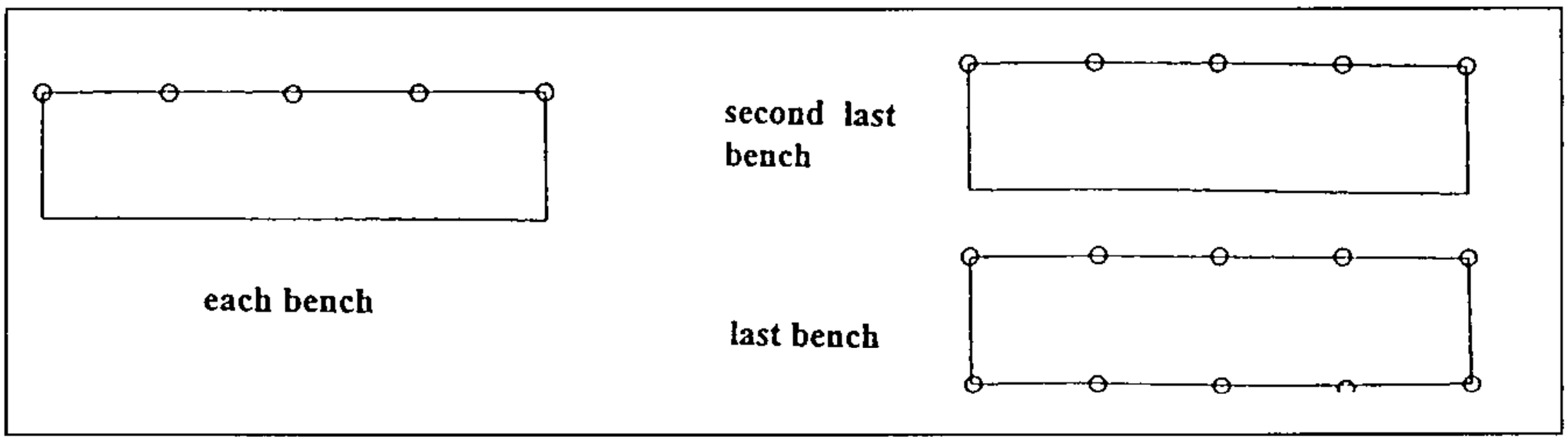

Figure 5. New sprinkler layout for benches.

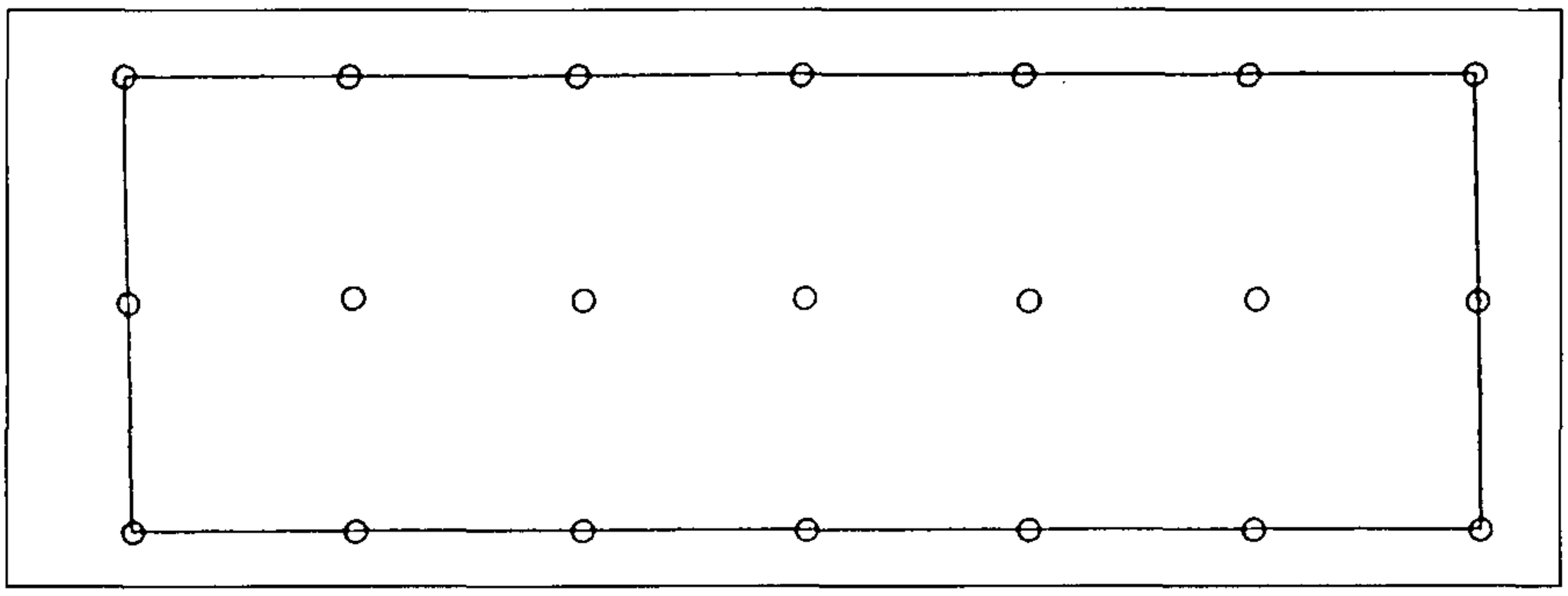

Figure 6. New sprinkler layout for production beds.

These new layouts use more sprinklers and wet a larger area outside the production areas, so how come they save water? Well the key is lower scheduling coefficients require less pumping time. This will save you water, provide more even watering, less fertiliser leaching, less throwaways, reduce selection time at dispatch, and produce better quality plants.

Still find it hard to believe? Well let's look at some figures.

Benches - 5 @ 1.8 m × 7.2 m = area of 64.8 m^2

	Conventional layout (Figure 2)	new layout (Figure 5)
Sprinkler discharge	46 litres h^{-1}	46 litres h^{-1}
Sprinkler spacing	1.8 M centres	1.8 × 2.7 M
Mean application rate	8.8 mm h^{-1}	9.5 mm h^{-1}
Scheduling coefficient	2.2	1.3
Time to apply 5 mm to driest container	$\frac{5 \times 60 \times 2.2}{8.8}$ = 75 min	$\frac{5 \times 60 \times 1.3}{9.5}$ = 41 min
No. of sprinklers	25	30
Volume applied	1438 litres	943 litres
Volume per m^2	22	14.6
Percentage saving	-	34%
Wettest container receives	12.5 mm	7.5 mm

Production beds - 12 m × 36 m bed = area of 432 m^2

	Conventional layout (Figure 3)	New layout (Figure 6)
Sprinkler discharge	318 litres h^{-1}	318 litres h^{-1}
Sprinkler spacing	6 m × 6 m (3 m from edges)	6 m × 6 m
Mean application rate	6.8 mm h^{-1}	8.8 mm h^{-1}
Scheduling coefficient	3.3	1.25
Time to apply 5 mm to driest container	$\frac{5 \times 60 \times 3.3}{6.8}$ = 145 min	$\frac{5 \times 60 \times 1.25}{8.8}$ = 43 min
No of sprinklers	12	21
Volume applied	9222 litres	4786 litres
Volume per m^2	21.3 litres	11.1 litres
Percentage saving		48%
Wettest container receives	24 mm	7.1 mm

So you're interested enough to calculate the Sc for your own system? It's a little time consuming to do so but quite simple. You will need some containers, in the Waterwork workshops we use round take-away food containers, but any container the same size will do. Lay them out on a 1 to 2 m grid over a good proportion of the area to be tested.

Now run the irrigation system for the normal length of time you might use. Using a reasonably accurate measuring cylinder, go around and measure how much water is in each container an record these on a sheet of paper. Total up the amounts recorded and divide by the number of containers you use. This will give you the average.

Now look at the original figures to find the smallest amount of water you measured. Get your calculator and find out the Sc by dividing the average by this smallest volume. If you have a result of less than 1.5 then congratulations. If not you are probably overwatering and leaching excessive fertilisers from your containers. Time spent at a Waterwork workshop could be time well spent.

LITERATURE CITED

Rolfe, C.J. 1994. Managing Water in Plant Nurseries. HRDC, NIAA, NSW Agriculture.

Cresswell, G.C. and **D.O. Huett.** 1996. Managing Nursery Runoff. NSW Agriculture.

Rolfe, C.J. and **A. Atkinson.** 1996. Waterwork. A competency-based homestudy and workshop package aimed at improving nursery irrigation, drainage and recycling. NSW Agriculture.