Desk-Study to gather and collate information on irrigation systems relevant to container nursery stock towards improving precision of water delivery (and scheduling).

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Project objective 1.1

Introduction

The purpose of this desk-study is to show the scope of irrigation equipment currently available, but also to identify gaps in our knowledge about the performance and best application of existing systems. It will also give pointers for research needs to be undertaken within this LINK project, or if appropriate, future projects.

The aim is also to highlight areas where improved performance or equipment functionality is needed which might, in turn, identify a need for a modification of a product or development of a novel irrigation system.

The context of the desk-study is within the objective of the project to make more effective use of water in HNS production and in particular, to develop precision irrigation scheduling and the application of 'lean' and RDI irrigation regimes. An important project objective is the development of a prototype gantry irrigation system linked to an infrared imaging or thermometry system. This will enable crop water stress levels to be accurately measured in space and time, possibly down to individual plant level, and plant or zone specific doses of irrigation to be precisely applied.

This document is not intended to be a comprehensive catalogue, but examples of sprinklers and other irrigation equipment thought most applicable for container HNS have been selected covering the different methods of water delivery. Some details of manufacturers and suppliers where more comprehensive details of product ranges can be accessed, are listed at the end.

This desk study report is currently just a first draft. It is presented as a working document, and can be updated during at least the first part of this LINK project. Comments and further input by consortium members, or others if it is appropriate to circulate this more widely, is welcomed. In particular the identification of important products or areas of knowledge not yet included.

If of sufficient value, an update could form the basis of a reference source for the wider industry either as an output from this project or through HNS 122 or subsequent knowledge transfer project.

General principles

As with many other ventures, it is important to think about your aims and objectives for irrigation on the nursery first, and how to best match specific requirements for crop types, production and handling systems around the nursery, before getting bogged down with different products, control systems etc. Irrigation and water management should be an integral part of the production process. However, for most nurseries there are ample opportunities for upgrading existing systems, but these will have to fit within existing cropping structures, layouts, service provision and other constraints. It may be,

for example, that one is committed to using overhead sprinklers of some sort for the time being, but that minor and inexpensive modifications to sprinkler spacing or choice of nozzle could make big performance benefits.

Correct design is essential for success. Some of these issues have been covered in the HDC Factsheet *16/05 Measuring and improving performance of overhead irrigation for container-grown crops* and will not be covered again here. Other excellent sources of information include:

Managing water in plant nurseries by Rolfe, C; Yiasoumi, W, and Keskula, E. 2000. Published NSW Agriculture, Australia.

Some 2005 updated Water Management guidelines for the Australian nursery industry are available as a free download and contains a lot of helpful information.
http://www.ngia.com.au/docs/Water_Manage_BMPG.pdf

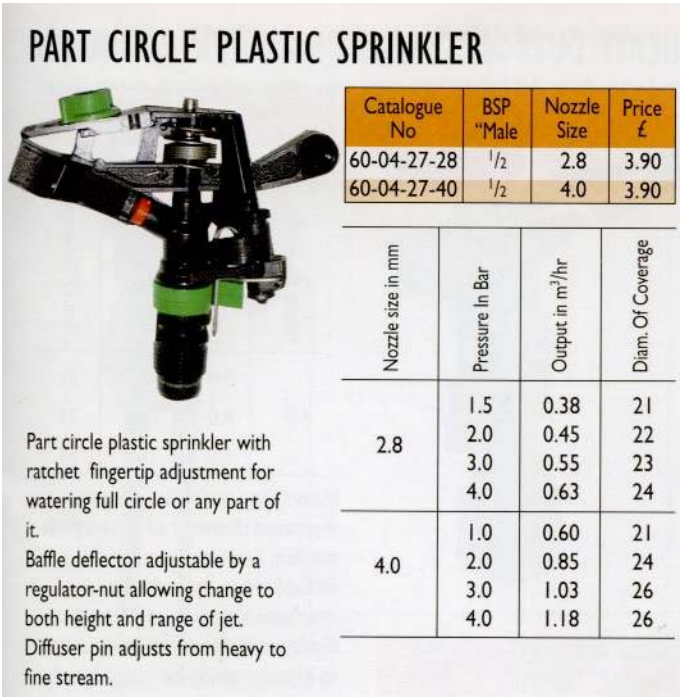
Irrigation Application Systems

Impact sprinklers

These produce a jet of water from one or two nozzles on a sprinkler head that swivels incrementally in short arcs due to the jet hitting a deflector spoon and weighted arm which moves against a spring. This is a popular choice with many nurseries and large areas can be covered with relatively few sprinklers. There is a wide range of designs available from several manufacturers, and cover sprinklers for large-scale field or orchard irrigation with wetting diameters almost up to 50 m (when rain guns take over), down to about 15 – 25 m more suitable for nursery use.

Typical trajectory angles of jets are 23° - 30°, but low angle sprinklers with e.g. 10° trajectories maybe used in orchards where it is necessary to keep the jet beneath the tree canopy. Also, some may incorporate a 'stream straightener' to improve performance under windy conditions.

Impact sprinklers are either full circle or part circle in operation. Most part circle types readily allow the arc to be adjusted from near full to part circle operation by adjusting a couple of clips at the sprinkler base. It is usually good practice to run sprinkler lines down edges of a bed or irrigated block, and part circle sprinklers here can be useful to reduce throw onto pathways, or sides of tunnels or glasshouses if used under protection. However, it is better ***to use an arc of e.g. 220°*** rather than 180° outdoors to help reduce insufficient wetting of edge pots due to wind drift. Also, impact sprinklers set to ***part circle will apply a higher precipitation rate*** than the same type set to full circle as the jet simply passes over a given arc of pots more frequently.



Naan 427 AG part circle sprinkler

Several impact sprinklers enable adjustment of the trajectory and degree of stream break-up and therefore range, through use of a baffle deflector and diffuser pin. ***In practice these are likely to be erratically or incorrectly adjusted on many nurseries.*** Typically there is just one or, as in this case, two nozzle sizes. ***Using the correct nozzle and maintaining the designed for pressure throughout a system will have a significant effect on the output and uniformity achieved.***

PART CIRCLE METAL SPRINKLER

Catalogue No	BSP "Male	Nozzle Size	Price £
60-04-23-40	1/2	4.0	7.00

Nozzle size in mm	Pressure In Bar	Output in m^3/hr	Diam. Of Coverage
4.0	1.5	0.73	23
	2.0	0.85	25
	3.0	1.03	27
	4.0	1.18	28

Part circle brass sprinkler with fingertip adjustment for watering full 26m circle or any part of it. Baffle deflector controls height of jet and diameter of circle. Diffuser pin adjusts from heavy to fine stream.

Naan also produce a range of brass bodied impact sprinklers.

PREMIER

Catalogue No	BSP "Male	Nozzle Size	Price £
59-00-20	3/4	4 x 2.5	13.00

Nozzle size in mm	Pressure In Bar	Output in m^3/hr	Diam. Of Coverage
4.0 x 2.5	1.5	0.99	23.4
	2.0	1.13	25.7
	2.5	1.25	26.6
	3.0	1.35	27.1
	3.5	1.45	27.4

The *Pope Premier* sprinkler (full circle) is also brass and uses two jets of different sizes.

The *Rainbird 2045-PJ* sprinkler is one of a large range of impact sprinklers from the US company. This one is used on some UK nurseries.

Flow rate 0.34 – 1.45 m^3/h
Radius 6.7 – 13.4 m (dia 13.4 m – 26.8 m)

2045-PJ

1/2" Full or Part Circle, Plastic Impact Sprinkler

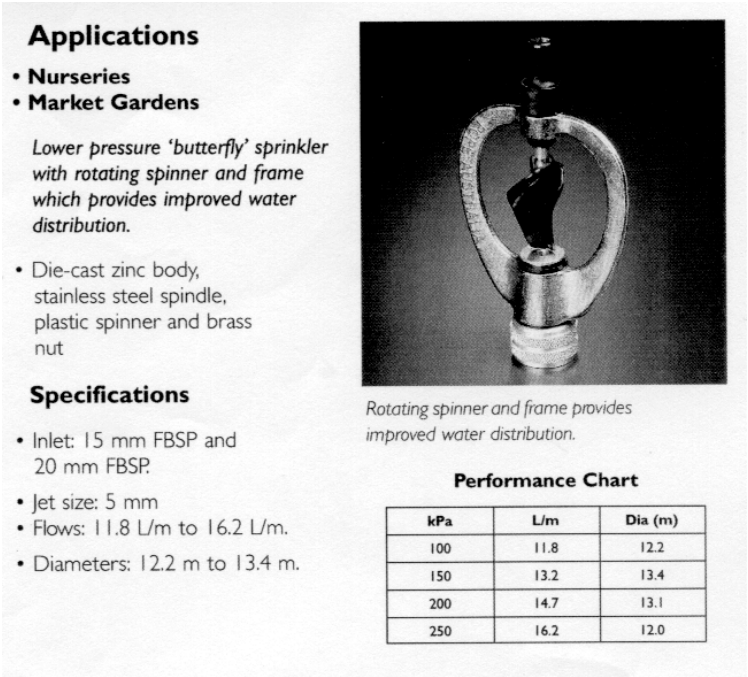
Bearing: 1/2" Male NPT, Plastic
Trajectory Angle: 23°
Operating Range: 25-60 psi
Flow Rate: 1.5-6.4 GPM
Radius: 22-44 ft.

A less well known company, *Palaplast*, based in Greece, but with UK agents also produce a range of five types of impact sprinkler of mainly plastic construction. The three full circle models have twin nozzles. There is a choice of three or four nozzle sizes with each model.

Summary impact sprinklers:

- Relatively inexpensive and quick to install for large area coverage
- Can be susceptible to wind drift with large proportion of small droplets due to jet break up with impact spoon and diffuser pin
- Requires careful design of layout with correct spacing of nozzles, adjustment of trajectories and adherence to correct operating pressures to get good results
- Application rates can be too high with some designs
- Part circle operation useful to avoid excessive overspill from crop area, but note comments about 220° arc instead of 180° at bed edges. It is also better to get good sprinkler overlap with overspill for lower SC uniformity that will also reduce water consumption (see Factsheet 16/05)

Butterfly sprinklers

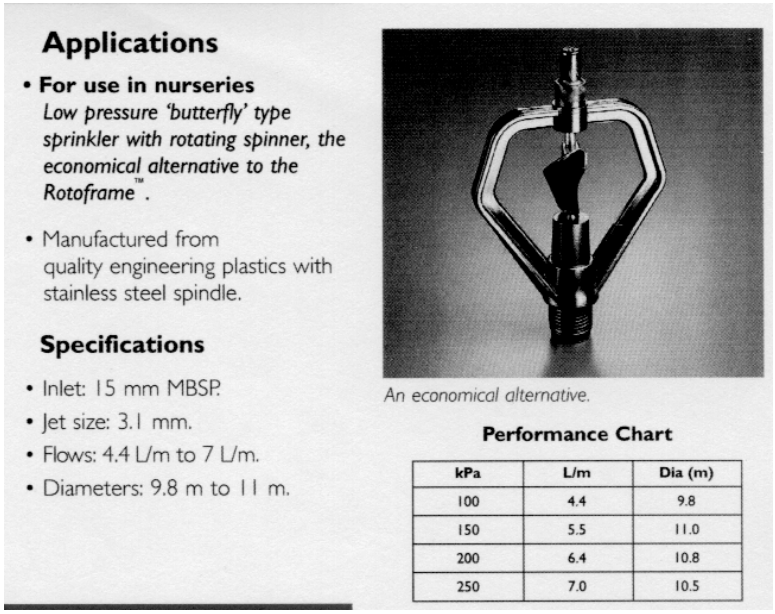


Pope Rotoframe sprinklers are widely used on many nurseries. Only one choice of nozzle size though this spec. (from Toro Ag Irrigation supplier) lists 5 mm jet size whereas other UK distributors refer to 4.5 mm jet.

Output here at 1, 1.5, 2, 2.5 Bar = 0.71, 0.79, 0.88 and 0.97 m^3/h respectively.

Rotoframes have a high trajectory – arguably if droplet sizes are large, this should give ***better foliage canopy penetration.*** However susceptible to ***excessive misting if run at high***

pressures. Rotoframes have a reputation for poor distribution, however I have recorded good distribution from a 5m x 5m spaced layout.



Applications

- **For use in nurseries**
  Low pressure 'butterfly' type sprinkler with rotating spinner, the economical alternative to the Rotoframe™.
- Manufactured from quality engineering plastics with stainless steel spindle.

Specifications

- Inlet: 15 mm MBSP.
- Jet size: 3.1 mm.
- Flows: 4.4 L/m to 7 L/m.
- Diameters: 9.8 m to 11 m.

An economical alternative.

Performance Chart

kPa	L/m	Dia (m)
100	4.4	9.8
150	5.5	11.0
200	6.4	10.8
250	7.0	10.5

This is a plastic bodied alternative to the Rotoframe with a lower application rate. No practical experience of this model.

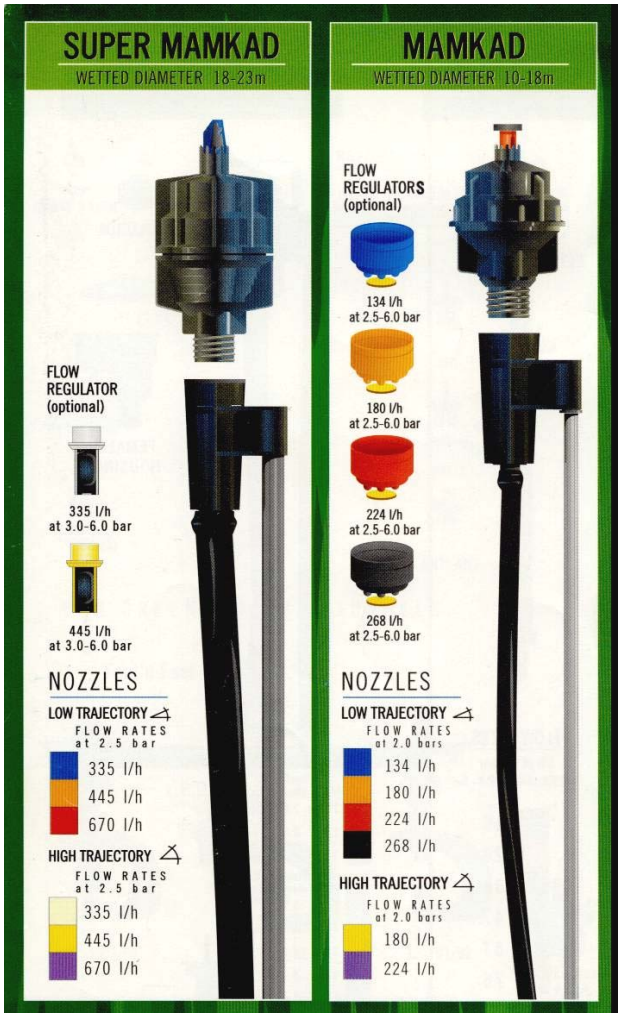
Summary Butterfly sprinklers:

- Widely used though poor reputation for uniformity
- Can give good results if properly spaced and run at correct pressure
- Outdoor use only as jet trajectory too high for tunnels / glasshouses

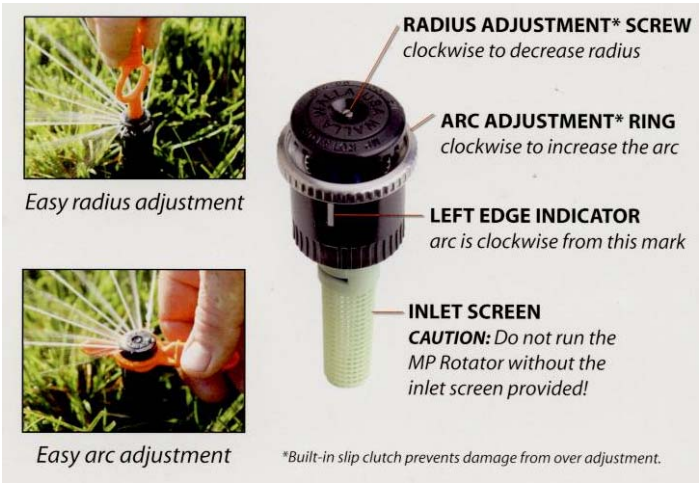
'Rotating jet' sprinklers

These give a relatively gentle application rate from either a single jet that rotates (e.g. Mamkad / Super Mamkad), or a multi-stream rotor (e.g. MP Rotator). Typically these are installed at closer spacings than impact or butterfly sprinklers. ***In theory, there should be a higher proportion of larger droplets from the jet stream with less misting and better performance in windy conditions than other overhead sprinklers.***

There is limited nursery experience with these sprinklers yet in the UK. Both the *Mamkad* and *MP Rotator* sprinklers are being used on one nursery in the HNS 122 project, but a more detailed study of their performance at a research site might be justified.



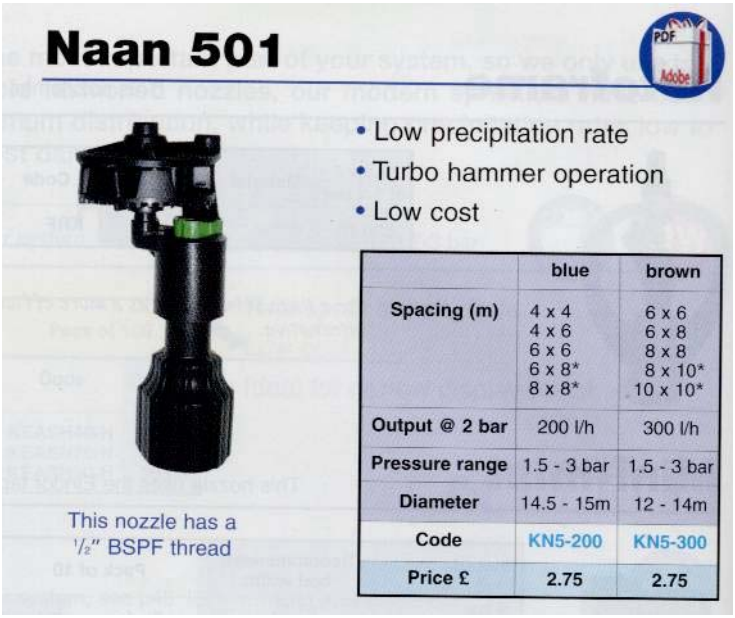
The *NaanDan Mamkad* (10 – 18 m wetted dia) and *Super Mamkad* (18 – 23 m dia) sprinklers have a several nozzle sizes and outputs in both low and high trajectory jets. They only have one moving part – the nozzle is driven by a stainless steel ball which rolls around a chamber under water pressure.



The *MP Rotator* is from the US *Walla Walla Sprinkler Company*, a subsidiary of *Nelson Irrigation Corporation.* It is a relatively new product, initially targeted at the landscape market, but is receiving interest for horticultural nursery irrigation.

There are three ranges of *MP Rotator* sprinklers. The MP1000 (2.5 – 4.6 m radius), MP2000 (4 – 6.4 m radius) and MP3000 (6.7 – 9 m radius). The MP1000 has a 90°-210° arc, but the MP2000 & 3000 also have 210°-270° and 360° heads. Arcs and radius can be adjusted on the relevant heads. A selling point of these sprinklers is their ***matched precipitation rate*** even after the arc and radius has been adjusted. This means that, unlike impact sprinklers, part circle *MP Rotators* along bed edges should be applying the same mm/h as full circle ones in the centre of the bed.

Rainbird also supply a multi-stream rotating nozzle – again primarily aimed at the landscape / sports turf application. These typically are installed in pop-up spray heads. Spray radius can be adjusted, and they either come in quarter, half or full circle, or variable arc nozzles (VAN) with full adjustability from 0 – 360°.



Naan 501

This nozzle has a ½" BSPF thread

- Low precipitation rate
- Turbo hammer operation
- Low cost

	blue	brown
Spacing (m)	4 x 4 4 x 6 6 x 6 6 x 8* 8 x 8*	6 x 6 6 x 8 8 x 8 8 x 10* 10 x 10*
Output @ 2 bar	200 l/h	300 l/h
Pressure range	1.5 - 3 bar	1.5 - 3 bar
Diameter	14.5 - 15m	12 - 14m
Code	KN5-200	KN5-300
Price £	2.75	2.75

The *Naan 501 Turbo hammer* sprinkler is typical of neither the impact or rotating jet types, but should be mentioned as it is promoted for orchard, nursery and greenhouse use. No personal experience with this range.

Summary Rotating Jet sprinklers

- Offer low precipitation rates compared to other traditional impact or butterfly sprinklers
- Jets *should* give less 'misting' and wind drift
- *May* give better performance outdoors in windy conditions
- Typically higher density of sprinklers than impact types thus suitable for nursery layouts where smaller irrigated areas are required to cope with a range of crops and irrigation schedules. Higher sprinkler densities should also provide more robustly uniform distribution
- Some units can be more expensive per unit area to install, but not prohibitively
- Variable arc / radius adjustment with matched precipitation rate may be advantageous for MP Rotator type
- As yet little comparative performance data for nursery use in the UK

Mini and micro sprinklers

There is a vast range of products from many manufacturers so only a small selection have been included here. As the name suggests, they are of relatively low output, small coverage compared to other overhead sprinklers. They cover those suitable for both outdoor and protected use, to those with very small or mist droplet sizes that would be only suitable for use under protection. Some of the very fine droplet and mister types are more suited for propagation or air-cooling applications than mainstream container irrigation. The main advantages of mini sprinklers for container nursery stock use are their suitability for ***irrigation layouts where smaller and individually scheduled areas are required.*** They are also ***relatively inexpensive, require smaller pipework infrastructures,*** and can give ***good uniformity on properly designed installations***.

Optimising distribution pattern also means ensuring the ***correct height of nozzles above the crop.*** One of the advantages of mini and micro-sprinklers is that there is often ***flexibility for installation method*** i.e. the same design nozzle can often be mounted on various types of risers and support stakes from the floor, inserted directly into sprinkler laterals in the roof of protected structures, or hung inverted from ***dropper tubes*** from overhead pipes. E.g. rather than having to adjust the height of overhead pipework to cope with batches of different height crops, it may be more convenient to

mount the sprinkler on an appropriate length dropper tube (weighted to minimise swinging during operation).

Although there are many different variations and design, mini and micro sprinkler operating principles fall into some main groups:

Pinjet types, where water is forced under pressure through a small orifice and hits a 'pinhead' where it is broken up into fine droplets and mist.

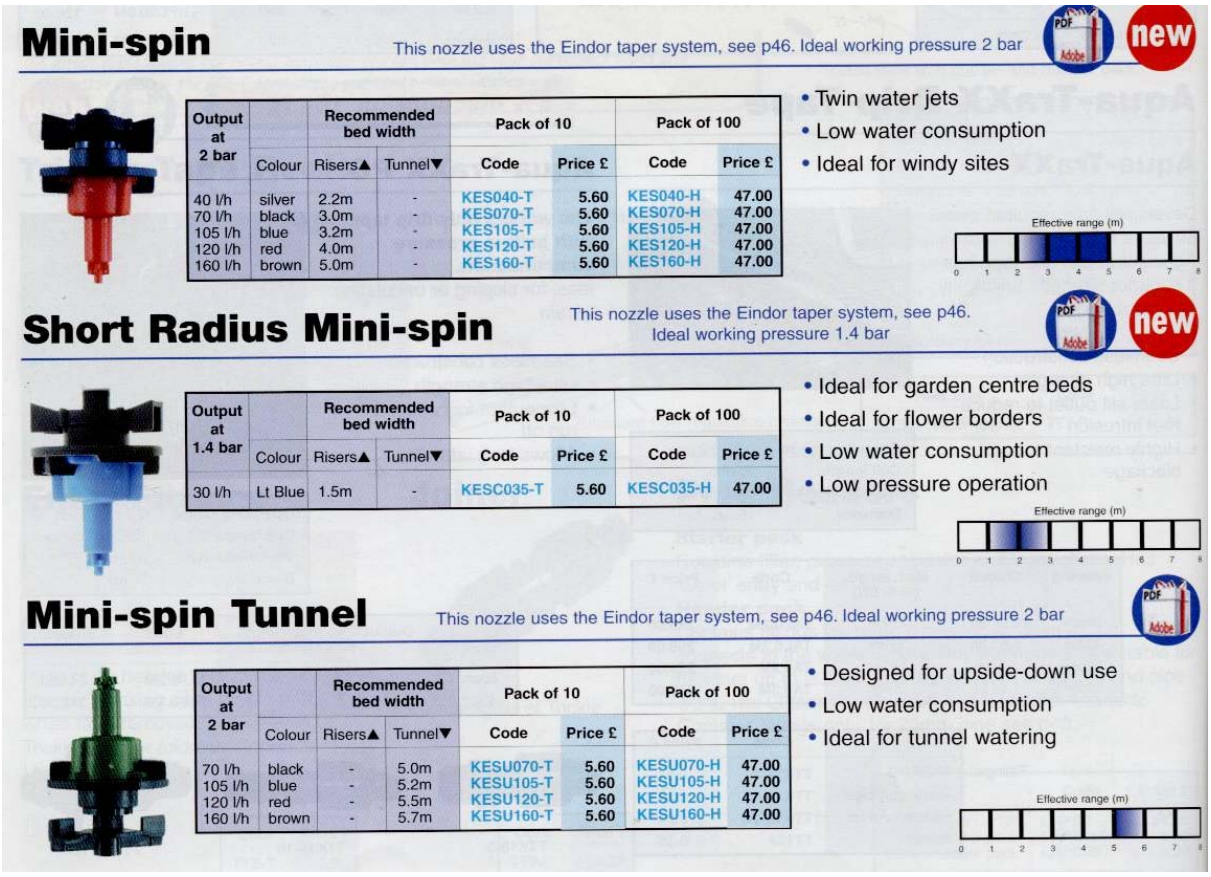
Anvil types. Also involve a jet striking a surface to break it into smaller droplets, but the anvils come in a range of different designs, e.g. with grooved surfaces or teeth to direct the flow. Many of these include ***fixed part-circle sprinklers*** for use along bed, tunnel or glasshouse edges. Generally output from these fixed sprinklers ***is not as uniform as from spinning types*****,** though I've no comparative data to verify this.

Spinning rotor types. Water either squirts from angled jets causing rotation, or a jet is directed onto a swivel or and anvil piece that rotates – either way the degree of atomisation is normally less than a fixed anvil or pinjet design.

Some mini sprinklers and sprayers from the *Palaplast* range. For the spinning types there are up to 11 nozzle sizes available with outputs from 40 – 300 l/h and coverage diameters of 5.0 – 12.0 m.

The following are a selection from the Israeli *Eindor* range for which *Access Irrigation Ltd* are agents. *Eindor* use a lot of push fittings, which are easy to assemble and

usually secure but care must be taken not to overpressurise irrigation lines. The *Eindor 861* mini sprinkler was used outdoors at Efford in the previous Water LINK 1 project to achieve very uniform application over the experimental plots of 3 litre *Hydrangea*, *Forsythia*, and *Cotinus*.



Mini-spin

This nozzle uses the Eindor taper system, see p46. Ideal working pressure 2 bar

new

Output at 2 bar		Recommended bed width		Pack of 10		Pack of 100	
	Colour	Risers▲	Tunnel▼	Code	Price £	Code	Price £
40 l/h	silver	2.2m	-	KES040-T	5.60	KES040-H	47.00
70 l/h	black	3.0m	-	KES070-T	5.60	KES070-H	47.00
105 l/h	blue	3.2m	-	KES105-T	5.60	KES105-H	47.00
120 l/h	red	4.0m	-	KES120-T	5.60	KES120-H	47.00
160 l/h	brown	5.0m	-	KES160-T	5.60	KES160-H	47.00

- Twin water jets
- Low water consumption
- Ideal for windy sites

Effective range (m)

Short Radius Mini-spin

This nozzle uses the Eindor taper system, see p46. Ideal working pressure 1.4 bar

new

Output at 1.4 bar		Recommended bed width		Pack of 10		Pack of 100	
	Colour	Risers▲	Tunnel▼	Code	Price £	Code	Price £
30 l/h	Lt Blue	1.5m	-	KESC035-T	5.60	KESC035-H	47.00

- Ideal for garden centre beds
- Ideal for flower borders
- Low water consumption
- Low pressure operation

Effective range (m)

Mini-spin Tunnel

This nozzle uses the Eindor taper system, see p46. Ideal working pressure 2 bar

Output at 2 bar		Recommended bed width		Pack of 10		Pack of 100	
	Colour	Risers▲	Tunnel▼	Code	Price £	Code	Price £
70 l/h	black	-	5.0m	KESU070-T	5.60	KESU070-H	47.00
105 l/h	blue	-	5.2m	KESU105-T	5.60	KESU105-H	47.00
120 l/h	red	-	5.5m	KESU120-T	5.60	KESU120-H	47.00
160 l/h	brown	-	5.7m	KESU160-T	5.60	KESU160-H	47.00

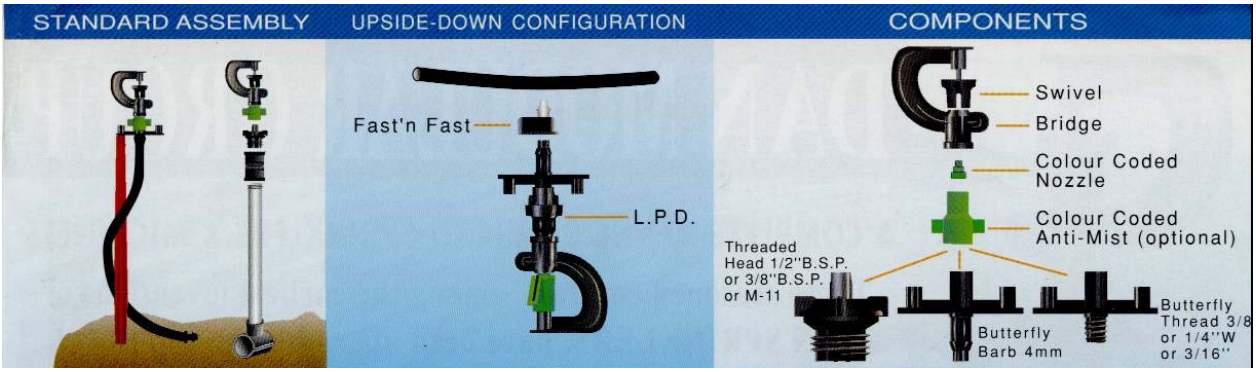
- Designed for upside-down use
- Low water consumption
- Ideal for tunnel watering

Effective range (m)

NaanDan (amalgamation of the former Naan and Dan irrigation companies) also have a well-established and comprehensive range of mini and micro-sprinklers. As with some other manufacturers, they offer a ***modular assembly system*** so that components can be mixed and matched as required. For example bases with ½" and ⅜" BSP, M-11 or WW threads or barbed fittings allow substitution of nozzles into existing pipelines provided spacings are correct. The bridge assembly will accept a range of different swivels or static spreaders, which can be combined with 10 coloured coded nozzles with 2 Bar flow ratings from 35 to 300 l/h. The option of adding a ***leakage prevention device (LPD)*** is particularly worthwhile for glasshouse systems with overhead pipelines and possibly dropper tubes, as they shut off the flow smartly when the valve is closed, thus preventing dripping. Also by keeping the lines full of water, all sprinklers start up quickly together. This is particularly helpful when pulse irrigation is practiced with several short applications separated by off periods for water absorption.

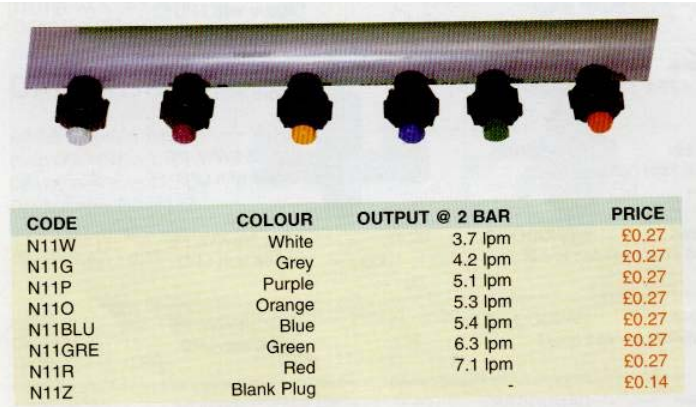
An ***anti-mist device*** can also be fitted between the base and the rest of the assembly. This acts rather like a venturi in reverse; the water jet passes through a small expansion chamber, which reduces the amount breaking into fine mist droplets. The distribution pattern from many nozzles is often roughly 'triangular', with output tailing off gradually with distance from the nozzle. Overlap from correctly spaced adjacent sprinklers is thus required to maximize uniformity. The addition of an anti-mist device increases the

proportion of larger droplets, which have greater momentum and increase the amount of water reaching the edge of the spray pattern leading to a 'squarer' output. This is particularly useful where it is necessary to ***schedule individual glasshouse or tunnel bays independently where subjects or plant batches can be grouped according to their irrigation need***. Typically 80% or more of the output from the irrigation lines in a bay can be restricted to that bay, and thus enable a very different water regime to an adjacent bay with little overspill to cause problems. To achieve good uniformity, however, the in-line nozzle spacing needs to be quite close (50 cm or 100 cm).



Examples of *NaanDan's* modular sprinkler system components (above) for upright or upside-down configuration. Also two types popular under protection; the *Upside-Down Green Swivel* in a conventional bridge assembly, and the bridgeless *Green Spin* nozzle.

While LPD's will prevent drips at the start and end of irrigations, a small amount of dripping will run off sprinkler bridges during operation. The ***bridgeless designs*** such as the *NaanDan* and *Eindor* examples shown will eliminate this.



CODE	COLOUR	OUTPUT @ 2 BAR	PRICE
N11W	White	3.7 lpm	£0.27
N11G	Grey	4.2 lpm	£0.27
N11P	Purple	5.1 lpm	£0.27
N11O	Orange	5.3 lpm	£0.27
N11BLU	Blue	5.4 lpm	£0.27
N11GRE	Green	6.3 lpm	£0.27
N11R	Red	7.1 lpm	£0.27
N11Z	Blank Plug	-	£0.14

The ubiquitous ***Pinjet nozzles*** (left) have been used for irrigating protected crops for decades. While they may have been fine for whole house irrigation of soil-grown crops, or for applying heavy doses to leach out surplus salts at the end of a tomato crop, they apply water far too fast for container crops. Even the lowest output nozzles are rated at 220 l/h. ***Measurements on nurseries are typically 75 mm/h or more and often cause puddling, heavy dripping from glasshouse structures etc***. Pinjet layouts are also usually designed to for overall watering with full overlap between bays, ***which makes it impossible to schedule bays independently***.

Summary mini and micro sprinklers

- Avoid pinjet nozzles for container crops where possible as output rates are too high with little layout flexibility for scheduling. Where they have to be retained, fit anti-drip valves behind nozzles, and use pulse irrigation to effectively reduce output rates.
- A vast range of other products are available with lots of flexibility for installation on various stakes and risers or from overhead pipelines with optional droppers. Those producing coarse enough droplet sizes are equally suitable for outdoor use as well as under protection.
- Mini sprinklers enable small and medium width beds to be irrigated economically, with the advantage that irrigated areas can be split into smaller units to suit the mixed crop requirements that typify many container nursery stock nurseries.
- 'Squarer' distribution patterns from the mini-sprinklers using the anti-mist devices can enable discrete bays within structures to be irrigated independently and uniformly with little overspill. This should make it easier for production managers to match irrigation schedules to crop requirements.
- Those with rotary jets will typically give more uniform and predictable results than fixed anvil nozzles. It is difficult to engineer fixed anvils to give even distribution around the wetted arc, and any deposit, such as limescale, left on the nozzle will affect the pattern.

Drip and mini spray-stake irrigation

This section will ignore trickle tape and in-line drippers, which are primarily intended for soil grown crops. They can be used successfully, however, for larger containers as an alternative to dripper leads, where outlets down a line match pot spacings. Also, drip tapes are commonly used with capillary matting and some sand bed sub-irrigation systems.

For container nursery-stock, pot drip irrigation has generally been regarded as viable only for containers of about 5 – 7.5 litres and above. This is largely a handling issue as working with a maze of stakes and leads on production beds can be slow and awkward. However, drippers are used widely in the pot plant sector with much smaller pots, though mainly with crops on benches. A ***major advantage with well set up pot***

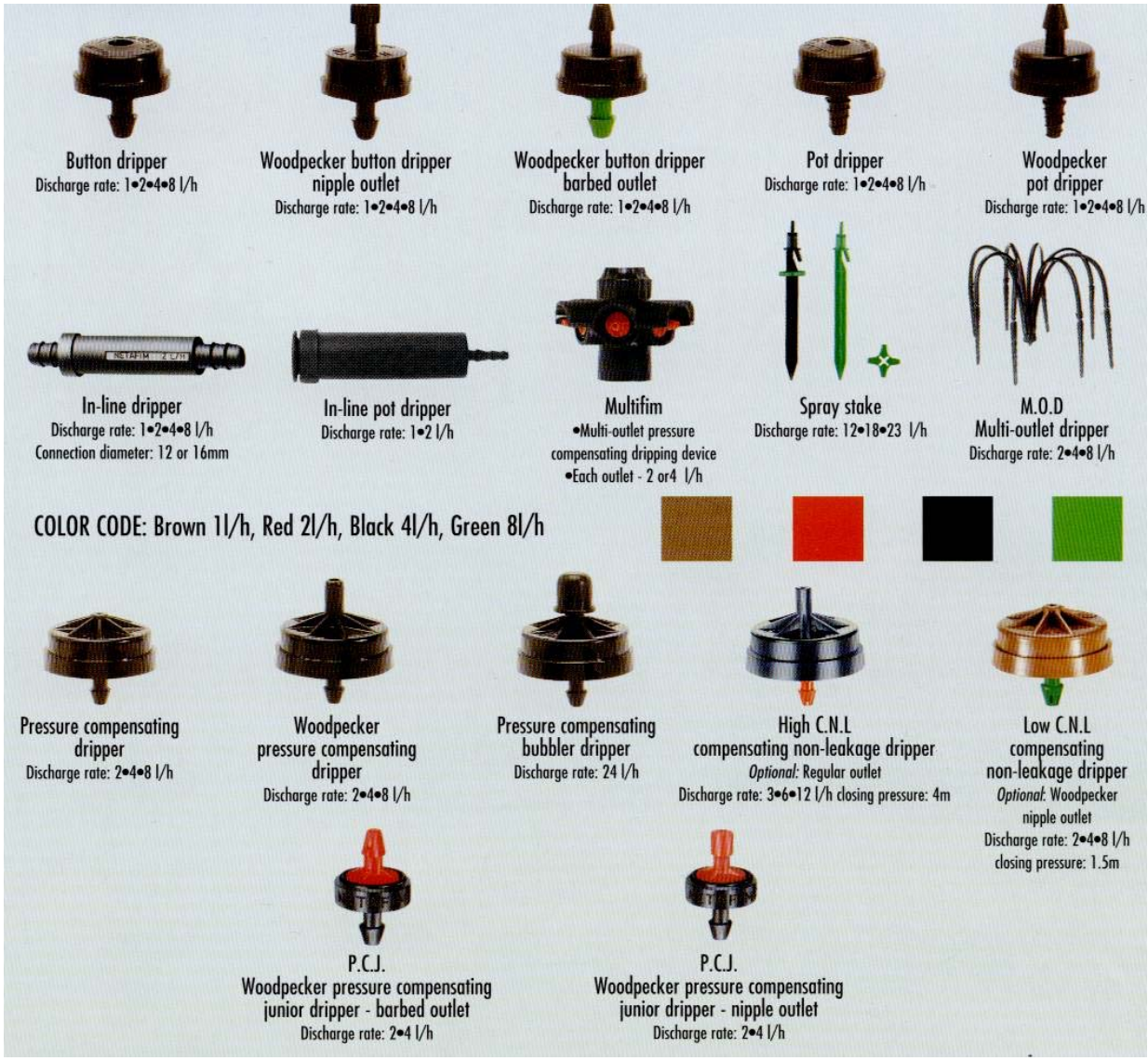
drippers is that they can irrigate much more uniformly than most overhead systems, because water is applied directly to the growing medium (but see comments below on application rate). For application of RDI regimes in trials, using pot drippers has been the method of choice up to now, but clearly it is desirable to improve application uniformity from other methods to enable lean and RDI regimes to be used more widely on nurseries.

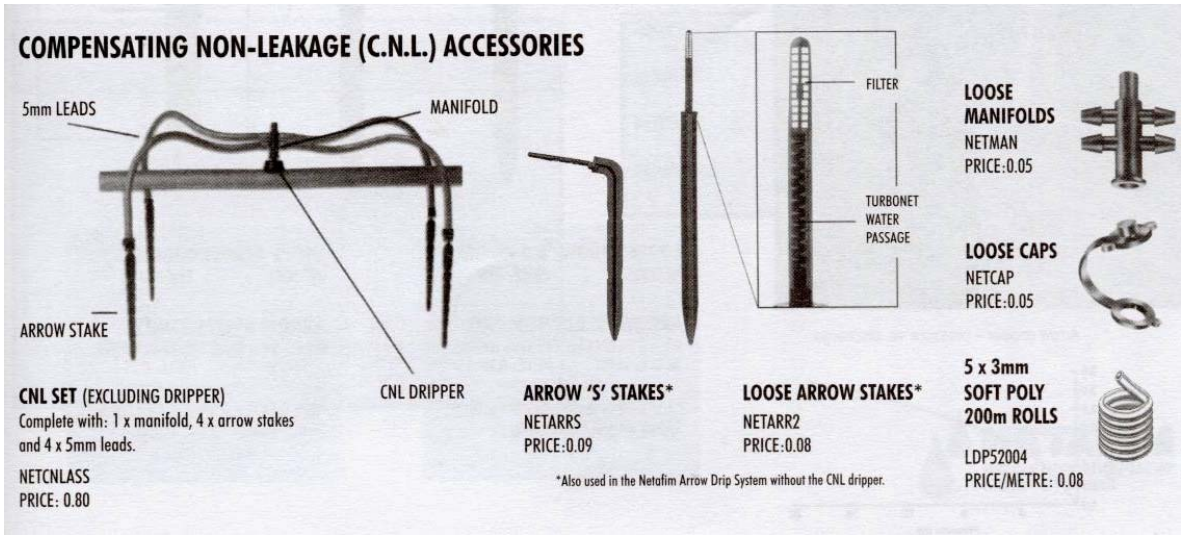
Pot drippers fall into two broad categories – those that are ***unregulated***, and ***regulated*** typically the ***Compensating Non-Leakage (CNL) dripper***. Unregulated drippers are available with several nominal output rates (typically 1, 2, 4 & 8 l/h), but these only apply at a particular supply pressure. Increasing or decreasing supply pressure will vary the actual output rate. Performance can be good with a carefully designed setup on a very level site and where the number of outlets on a lateral does not exceed the design maximum. However for many nurseries, crops are on a slope with varying row lengths, and ***in these situations it is essential that pressure regulated drippers are used***. The number of outlets must still not exceed the design maximum, and supply pressure must be adequate, but CNL drippers will help cope with varying supply pressure down the line. They will also ***'self-seal' at the end of the irrigation cycle*** when the pressure drops, which keeps the system primed so that all drippers start together at the beginning of the next cycle. ***This is particularly important where pulse drip irrigation is used***.

The effective application rate of drippers can be very high. For example, based on the surface area of a pot, a single 2 l/h dripper in a small 100 mm pot is applying water at a rate of 250 mm/h. In a typical 3 litre (190 mm) pot this falls to 70 mm/h, but this is still high, ***especially as all the water is being applied at a single point on the surface***. In this situation, it is difficult to wet up the whole volume of the pot without significant run-through. Measures to improve uniform wetting within the pot from drippers include:

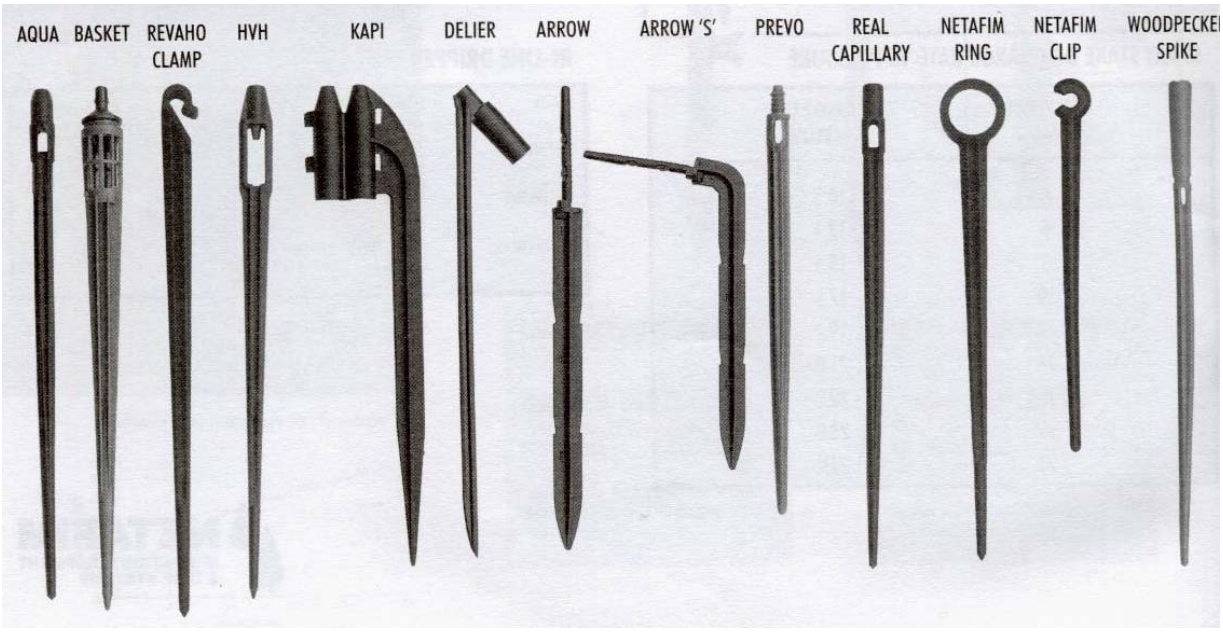
1. Several drippers per pot spaced over the surface (but this increases application rate!).
2. Pulse irrigation (leaving a gap of at least twice the 'on' time for water absorption and spread.
3. Ensuring sufficient fine grade particles within the medium to improve capillarity.
4. Addition of good quality and long-lasting wetting agents (surfactants). Small proportions of media ingredients such as loam or coir will also improve wetting.
5. A coarse mulch will help keep the top layer of the body of the medium moister and prevent it from drying and becoming hydrophobic.
6. Preventing media from drying down too far between irrigations and becoming hydrophobic (more difficult with RDI regimes).
7. Having a capillary standing surface such as matting or sand, or pot saucers, so that run-through water can be reabsorbed.

A range of unregulated and pressure compensated drippers are shown below. The use of a manifold to supply four dripper leads from a single CNL button is a popular way of setting up drippers. ***Unwanted dripper outlets can be capped off – e.g. when plants are sold selectively from a bed***.

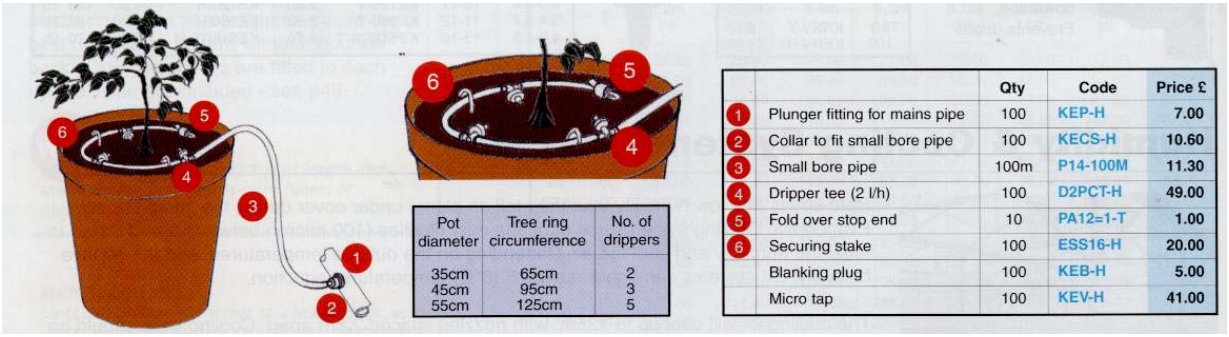

Button dripper
Discharge rate: 1•2•4•8 l/h
Woodpecker button dripper nipple outlet
Discharge rate: 1•2•4•8 l/h
Woodpecker button dripper barbed outlet
Discharge rate: 1•2•4•8 l/h
Pot dripper
Discharge rate: 1•2•4•8 l/h
Woodpecker pot dripper
Discharge rate: 1•2•4•8 l/h
In-line dripper
Discharge rate: 1•2•4•8 l/h
Connection diameter: 12 or 16mm
In-line pot dripper
Discharge rate: 1•2 l/h
Multifim
•Multi-outlet pressure compensating dripping device
•Each outlet - 2 or4 l/h
Spray stake
Discharge rate: 12•18•23 l/h
M.O.D
Multi-outlet dripper
Discharge rate: 2•4•8 l/h
COLOR CODE: Brown 1l/h, Red 2l/h, Black 4l/h, Green 8l/h
Pressure compensating dripper
Discharge rate: 2•4•8 l/h
Woodpecker pressure compensating dripper
Discharge rate: 2•4•8 l/h
Pressure compensating bubbler dripper
Discharge rate: 24 l/h
High C.N.L compensating non-leakage dripper
Optional: Regular outlet
Discharge rate: 3•6•12 l/h closing pressure: 4m
Low C.N.L compensating non-leakage dripper
Optional: Woodpecker nipple outlet
Discharge rate: 2•4•8 l/h closing pressure: 1.5m
P.C.J.
Woodpecker pressure compensating junior dripper - barbed outlet
Discharge rate: 2•4 l/h
P.C.J.
Woodpecker pressure compensating junior dripper - nipple outlet
Discharge rate: 2•4 l/h


COMPENSATING NON-LEAKAGE (C.N.L.) ACCESSORIES
5mm LEADS
MANIFOLD
ARROW STAKE
CNL DRIPPER
CNL SET (EXCLUDING DRIPPER)
Complete with: 1 x manifold, 4 x arrow stakes and 4 x 5mm leads.
NETCNLASS
PRICE: 0.80
ARROW 'S' STAKES*
NETARRS
PRICE:0.09
FILTER
TURBONET WATER PASSAGE
LOOSE ARROW STAKES*
NETARR2
PRICE:0.08
*Also used in the Netafim Arrow Drip System without the CNL dripper.
LOOSE MANIFOLDS
NETMAN
PRICE:0.05
LOOSE CAPS
NETCAP
PRICE:0.05
5 x 3mm SOFT POLY 200m ROLLS
LDP52004
PRICE/METRE: 0.08

There are many different delivery stakes that either fit into the end of dripper tube, or simply support the tube. The *Arrows* and some other types have filters and labyrinths fitted into them, which create turbulence and help prevent blockages. Also some stakes encourage the water to flow down them so it is absorbed by the medium below the surface, which helps reduce evaporative losses from the surface. A similar effect is encouraged in some field drip irrigation by the use of 'gravel vertical mulching' under the outlet.



For large diameter pots – e.g. with tree crops, *Access Irrigation* supply a *Drip Ring System* with several pressure compensated nozzles to supply water more evenly.



Pot diameter	Tree ring circumference	No. of drippers
35cm	65cm	2
45cm	95cm	3
55cm	125cm	5

		Qty	Code	Price £
1	Plunger fitting for mains pipe	100	KEP-H	7.00
2	Collar to fit small bore pipe	100	KECS-H	10.60
3	Small bore pipe	100m	P14-100M	11.30
4	Dripper tee (2 l/h)	100	D2PCT-H	49.00
5	Fold over stop end	10	PA12=1-T	1.00
6	Securing stake	100	ESS16-H	20.00
	Blanking plug	100	KEB-H	5.00
	Micro tap	100	KEV-H	41.00

Finally, various ***spray stake*** emitters can be used which emit a series of jets over the surface of the medium in the pot rather than at a single point. One type, recommended by *Revaho* is fitted to a high output PCJ dripper 12 l/h at the lateral, linked with a tube to a spray stake inserted at the edge of the pot. The water is thrown out 300 – 350 mm from the stake, so it is clearly only useful for larger pots.

Summary drip and mini spray stake irrigation

- Potential for good uniformity of application provided system designed well and preferably CNL drippers used.
- High outputs directed on a small zone of growing medium so run-through can be a problem unless pulse irrigation and wetting agents, fine media texture etc. used.

- Ensure good filtration to minimise blockages. Pre-season maintenance with e.g. Jet 5 or other cleaners to remove bicarbonate, fertiliser and other deposits.
- Less convenient for small pot sizes (< 5 litres) for container HNS systems at ground level.

Gantry or mobile boom systems

Developing a prototype gantry based system for infra-red monitoring and precision application of irrigation is one of the key objectives of this Water LINK project. Gantry irrigation is currently more popular for nursery stock in Europe, e.g. in Germany, Holland and Belgium than in the UK. Information on these systems has been less easy to find, however, than more established irrigation, and this section of the review needs further input.

The following photographs are from the website of our LINK consortium partner, *Denton Automation Ltd* http://www.dentonautomation.co.uk :

Nursery stock consultant, *John Adlam, Dove Associates*, has provided us with some information from the German gantry manufacturer *Rathmakers* . The information is in German, although the Google translation facility does a Pidgin English job of their website http://www.rathmakers.de from where the following illustrations have been taken:

Gantry irrigation is more widely used on cell pack and small module trays – such as pot and bedding production, where smaller volumes of water need to be applied.

Typically overlapping fan nozzles (similar to a herbicide boom) are used, but probably higher output versions.

For container HNS in e.g. 2 – 3 litre plus containers, some of the following questions arise:

- Given that maybe 300 – 500 ml of water may be applied to a 3 litre pot in a single irrigation, the gantry system will either need to undertake many passes to adequately water the crop, or will be applying it at an extremely fast rate. There is the obvious question of economics of gantry irrigation on a nursery (whether outdoors or under cover) where either a small number of units will take too long to travel from section to section, or a large number of units will have to run concurrently.

- If dropper tubes were used to apply the water, how fast would the boom travel over a crop of 3 litre pots? Would different applicators (e.g. a small diameter mini spray device) on the end of a dropper help spread the water more evenly onto the pot media surface?

Flood and drain capillary irrigation

Other forms of capillary irrigation (such as capillary matting or sand beds) will not be covered here, as they have been adequately reviewed in recent reports (HNS 107) and HDC factsheet *Capillary irrigation of container grown nursery stock 01/06*.

A recent visit to *Jan Lansen's* nursery, Spalding in March 2006 was illuminating. He is producing 2 million hardy perennials, ferns, ornamental grasses and bamboos per year on a 7 ha site. The whole area is now converted to flood and drain irrigation, and includes 0.5 ha of production beds under glass with the rest outdoors. Mechanical handling of benches of plants around the nursery on rails pulled by electric 'cars' makes for high efficiency. Trays of plants only need to be lifted to and from the actual bed area to the benches alongside. All the water is recycled, and the crops are entirely liquid fed.

Beds typically flood up in 6 minutes and drain down in 6 minutes. There are 107 beds in total, and the irrigation cycles and feeding are controlled by a Brinkman computer.

In this instance, pots are being wetted up to full capacity, and excellent uniformity with high efficiency is possible.

Would it be also possible to run a lean or RDI regime with this system using small doses of water?

Jan Lansen's herbaceous production area operating flood and drain irrigation.

Novel tray irrigation system

Work by Richard Beeson in Florida has shown a tray system in conjunction with overhead irrigation to be an efficient way of irrigating container HNS with large water savings. The principle is very simple, with containers stood in approx 1 m x 1.5 m shallow trays with a drainage hole drilled at 9 mm from the base. Overhead irrigation missing the pot or running through is effectively captured and reabsorbed, but the drainage hole prevents overdosing and waterlogging (at least in summer).

Could this system overcome some of the difficulties of applying RDI regimes to crops using overhead irrigation?

R&D Ideas from this Desk-Study

- Further investigation of crop canopy penetration by different types of sprinkler. This can be done with pot weighing tests before and after irrigation. Do heavier droplets from some sprinklers actually penetrate canopies better? How important is this compared to uptake of water through pot bases?

- Relative uptake of water from base of containers on different standing bases. Build on earlier Efford work from LINK 1. Important question in relation to RDI and scheduling for lean regimes.

- Develop earlier work in HNS 107a on use of mulching & wetters for improving water management and uniformity. Both run-through and water retention need to be controlled for effective scheduling. Also, reducing the proportion of water lost from evaporation from media surfaces should improve uniformity of water management in the crop.

- Test the distribution patterns from MP Rotators vs impact sprinklers or other types. Is the theory of less influence by wind really true?

- Generally, sub irrigation leads to least water stress, and it is a good system for maximising growth potential. However, can it be used to apply RDI or lean regimes? Cannot easily overcome breaking capillary contact with matting systems, but is there more potential with sand beds or flood and drain systems? Need to apply a limited and controlled dose to the base.

- Explore the potential for GP1 controllers to apply precision schedules under precision application systems.

- Modifications of the growing medium to improve capillarity and hence water movement within the pot.

Chris Burgess
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April 2006