DIY unpowered drip irrigation on sloping land with 95% uniformity

Dripper assembly with 20 drippers

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1. Introduction

Most drip irrigation applications on sloping land use PC (pressure compensated) drippers. A high pressure pump is usually required to ensure that all drippers within each zone are within the pressure range recommended by the manufacturer for pressure compensation. Furthermore, many zones are usually required to ensure that the drippers within each zone are within the pressure range recommended by the manufacturer for pressure compensation.

All of the above requirements for PC drippers make drip irrigation on sloping land from a header tank (or elevated water supply) very expensive.

This article demonstrates how drip irrigation on sloping land from a header tank can use NPC (non pressure compensated) drippers without compromising dripper uniformity throughout the irrigation application. It is assumed that the same drippers are used throughout the irrigation application. The irrigation controller is an Unpowered Terracotta Irrigation Controller.

Some key features are listed below.

1. The installation cost is a fraction that for an equivalent PC system.
2. Excluding the refilling of the header tank, the irrigation system is completely unpowered (no batteries, no solar panels, no electronics, no computers, and no WiFi).
3. A small low pressure water transfer pump may be required to refill the header tank between irrigation events.
4. The water discharge from each irrigation dripper during the irrigation event is approximately the same.
5. Provided that the control dripper has the same emitter discharge exponent as the irrigation drippers, the water discharge from each irrigation dripper during the irrigation event is independent of the water level in the header tank.
6. Provided that the irrigation system is designed so that frictional head loss along each lateral is negligible, the dripper uniformity throughout the irrigation application is better than 95%.
7. You can adjust the water usage rate by adjusting the control dripper on the Unpowered Terracotta Irrigation Controller.
8. You can adjust the interval between irrigation events by adjusting the float on the Unpowered Terracotta Irrigation Controller.
9. The irrigation system responds automatically to on-site evaporation and rainfall.
10. Simple, unpowered, and low tech, and therefore fewer things can go wrong.
11. Provided that you have a continuous water supply, you can leave your irrigation application unattended for weeks on end.
12. If the header tank runs out of water, the irrigation system starts again automatically as soon the header tank is refilled.

2. Installation

Step 1. Arrange laterals so that each lateral follows a different contour level. Use enough laterals so that every plant is at approximately the same level as one of the laterals. The laterals may be NPC dripline or 19 mm polypipe with online NPC drippers. Restrict the length of the laterals so that frictional head loss along the laterals is negligible.

Step 2. Define level zero as the contour level half way between the level of the top of the header tank and the level of the highest lateral. Connect the header tank outlet to the inlet of an Unpowered Terracotta Irrigation Controller with the control dripper at level 20 cm. Connect the outlet from the irrigation controller to a horizontal length of 25 mm polypipe at level 20 cm.

Step 3. Let h metres be the level of the top of the header tank.
Subdivide the slope into zones as follows:
Zone 1 (Z_1) is from level (–h) to level (-1.1*h)
Zone 2 (Z_2) is from level (-1.1*h) to level (-1.2*h)
Zone 3 (Z_3) is from level (-1.2*h) to level (-1.3*h)
and so on until all the laterals have been allocated to a zone.

Alternative Step 3. To achieve maximum dripper uniformity, do the planting in rows so that each row (or swale) follows a contour level. Each row has its own laterals at the same level as the row and each row becomes a zone.

Step 4. For each zone Z_i count the number of irrigation drippers N_i in the zone. Construct a dripper assembly using drippers with the same emitter discharge exponent (see Appendix) as the irrigation drippers. The flow rate of the dripper assembly should be the same as the total flow rate of the corresponding drippers in the zone. Attach the dripper assembly to the 25 mm polypipe in Step 2so that all the drippers in the dripper assembly are at level 20 cm.

Step 5. Polypipe is used to deliver water from the dripper assembly to the laterals in the zone. The diameter of the polypipe will depend on the slope of the land. For example, on steep sloping land 13 mm polypipe can be used. The drippers in the dripper assembly should be open to the atmosphere at all times.

To minimise frictional head loss along very long laterals you may need to deliver water from the dripper assembly to 3 points on the lateral, namely, at one sixth of the way, at half way, and at five sixths of the way.

The pressure at all of the drippers in the irrigation system (including the dripper assembly) is approximately the same. **Hence the discharge from each irrigation dripper will be approximately the same.**

Provided that the irrigation system is designed so that frictional head loss along each lateral is negligible and the irrigation zones are designed according to Step 4, the dripper uniformity throughout the irrigation application is better than 95%. The dripper uniformity can be further improved by increasing the number of zones.

There is no upper limit on the vertical gap between the dripper assembly and the irrigation drippers (for example, the irrigation drippers may be 50 metres lower than the dripper assembly).

If you want the water discharged by each irrigation dripper during the irrigation event to be independent of the water level in the header tank, replace the adjustable control dripper by a fractional dripper using 10 irrigation drippers (see the Unpowered Terracotta Irrigation Controller User Manual).

3. Recommended drippers

All drippers used for the irrigation and the construction of the dripper assembly should have the same emitter discharge exponent (see Appendix). To be sure that all the drippers have the same emitter discharge exponent, it is preferable that all the drippers are the same. The following recommendations will assist you in the construction of the dripper assembly.

On line drippers

Netafim NPC button drippers 2 lph, 4 lph or 8 lph (at 100 kPa), emitter discharge exponent 0.48, available on line from Dural Irrigation

Dripline

Netafim Aries HWD 13 mm dripline, 8 lph (at 100 kPa), 0.40 m spacing, emitter discharge exponent 0.46, available on line from Dural Irrigation

Netafim Aries HWD 16 mm dripline, 8 lph (at 100 kPa), 0.30 m spacing, emitter discharge exponent 0.46, available on line from Land & Water Technology

Using either of these high flow driplines allows you to use fewer drippers to construct the dripper assembly.

All of the driplines in the Netafim Aries range have an emitter discharge exponent of 0.46 and so you can choose any Aries dripline for your irrigation application. To exactly match the flow rate of the zone, you may need to include a few irrigation drippers in the dripper assembly as well as the 8 lph drippers.

4. Examples

Example 1

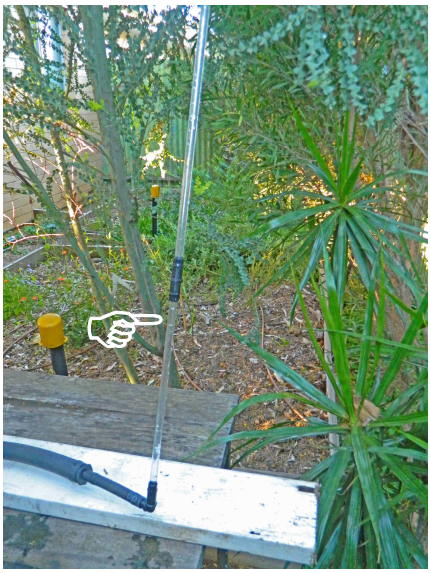
For this example there is one zone only and the irrigation drippers for the zone are 40 Netafim NPC 4 lph button drippers. The dripper assembly has 20 Netafim NPC 8 lph button drippers.

The pressure at the irrigation drippers and the drippers in the dripper assembly is 35 cm head.

1. The header tank is an elevated wheelie bin with the top of the wheelie bin 1.3 metres above the irrigation drippers.

2. The outlet from the header tank delivers water to the inlet of an Unpowered Terracotta Irrigation Controller with the control dripper 20 cm below the header tank outlet. The outlet from the Unpowered Terracotta Irrigation Controller delivers water to a length of 25mm polypipe 20 cm below the header tank outlet.

3. The dripper assembly has 20 Netafim NPC 8 lph button drippers inserted in to a short length of 19mm polypipe. The dripper assembly is connected to the 25mm polypipe.



4. A clear vertical tube indicates a pressure of 35 cm head at the dripper assembly.

5. An open pipe collects the water from the dripper assembly and directs the water into a funnel.

6. Polypipe delivers water from the funnel to the irrigation drippers. A clear vertical tube indicates a pressure of 35 cm head at the irrigation drippers.

7. The irrigation drippers are 40 Netafim NPC 4 lph button drippers

Example 2

For this example the header tank is a 1000 litre IBC (Intermediate Bulk Container) with the top of the header tank 2.6 metres higher than the highest lateral (h = 1.3 metres). There are 10 irrigation zones on sloping ground with a 13 cm vertical gap between successive zones. The irrigation application uses Netafim Aries dripline with 2 lph NPC drippers. The dripper assembly for each zone uses Netafim Aries HWD 13 mm dripline with 8 lph drippers.

The outlet from the header tank delivers water to an Unpowered Terracotta Irrigation Controller with the control dripper 20 cm below the header tank outlet. The outlet from the Unpowered Terracotta Irrigation Controller delivers water to a length of 25 mm polypipe 20 cm below the header tank outlet.

The table below shows the number of 2 lph drippers in each zone, and the number of 8 lph drippers in each dripper assembly.

Zone number	Number of 2 lph drippers in the zone	Number of 8 lph drippers in the dripper assembly for the zone
1	100	25
2	80	20
3	80	20
4	88	22
5	104	26
6	100	25
7	92	23
8	60	15
9	80	20
10	80	20

Each dripper assembly is connected to the 25 mm polypipe and an open pipe collects the water from each dripper assembly and directs the water via 13 mm polypipe to the laterals in the corresponding zone.

For this irrigation application it is important that the discharge from each irrigation dripper is independent of the water level in the header tank. Therefore the adjustable control dripper on the Unpowered Terracotta Irrigation Controller is replaced by a fractional dripper using 10 irrigation drippers.

Dripper assembly for zone 8 with 15 8 lph drippers using Netafim Aries HWD 13 mm dripline

The dripper assembly is inserted inside an open pipe.

The dripper assembly is ready to be connected to the 25 mm polypipe.

Appendix Emission discharge exponent

The Netafim Product Catalogue contains the following table for their button drippers.

DRIPPERS TECHNICAL DATA

Button drippers

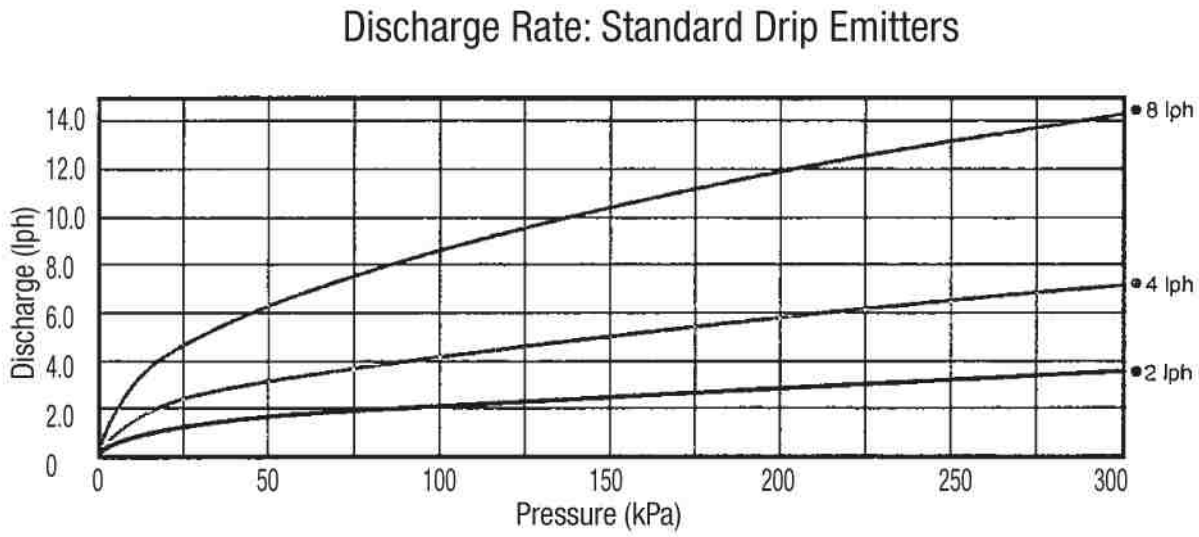
FLOW RATE* (L/H)	MAXIMUM WORKING PRESSURE (BAR)	WATER PASSAGES DIMENSIONS WIDTH-DEPTH-LENGTH (MM)	CONSTANT K	EXPONENT X	BASIS CODE COLOR	CAP COLOR CODE
2.00	2.0	0.98 x 0.89 x 50	0.662	0.48	Red	Black
3.00	2.0	1.05 x 0.95 x 50	0.993	0.48	Blue	Black
4.00	2.0	1.27 x 1.20 x 50	1.325	0.48	Black	Black
8.00	2.0	1.65 x 1.40 x 50	2.649	0.48	Green	Black

*Flow rate at 1.0 bar pressure

BUTTON DRIPPER
3MM BARB OUTLET

I draw your attention to the fact that all of the button drippers have a dripper discharge exponent of 0.48. If these drippers are used, the ratio of the flow rates of any two drippers is independent of pressure.

The Antelco Product Catalogue contains the following flow curve and table for their Agri Drip NPC drippers.



Performance		Standard 2 lph	4 lph	8 lph
Discharge (lph)	50 kPa	1.41	2.96	6.07
	75 kPa	1.73	3.58	7.35
	100 kPa	1.99	4.10	8.41
Discharge = K x Pressure^X	125 kPa	2.22	4.56	9.34
	150 kPa	2.42	4.96	10.18
Coefficient of Variation – CV		2.0%	2.0%	2.5%
Constant – K		0.208	0.471	0.966
Exponent – X		0.490	0.470	0.470
Minimum Cross Section (mm)		0.90x0.71	1.28x0.82	1.85x1.09

Agri Drip™ Classic
2 lph

Agri Drip™ Classic
4 lph

Agri Drip™ Classic
8 lph

The red, grey and green Agri Drip drippers do not have the same emitter discharge exponent. Note that the red dripper has an emitter discharge exponent of 0.49 and the grey and green drippers have an emitter discharge exponent of 0.47. Therefore, if you use only grey and green drippers, the ratio of the flow rates of any two drippers is independent of pressure.