INVESTIGATIONAL WORK WITH TRICKLE IRRIGATION

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INTRODUCTION

The trickle system of irrigation used successfully for a number of years in glasshouse cropping has been simplified for use on a field scale.

Pressures and flow rates are much below those used in conventional irrigation systems so that capital investment in pumps and supply mains is appreciably less.

Overall water use is considerably reduced by eliminating evaporation losses during application and supplying only the plants' exact requirements. In this way water sources normally considered too small for irrigation may be used.

The complete reticulation system for trickle consists of extruded polythene pipe of various densities and diameters and the simple method of jointing almost eliminates the need for propriety fittings.

Development for field use was started by Symcha Blass in Israel in 1962 and its application spread to Australia in 1965. It was soon being used on a practical scale in various forms in both these countries and recently it has aroused considerable interest throughout the world.

The system has been used and observed under New Zealand conditions by the New Zealand Agricultural Engineering Institute at Lincoln and elsewhere for the past two seasons. Within the last year many commercial installations have come into use in various parts of the country.

DESCRIPTION

The basic components of the system are a header pipe, usually of 1½in or 2in diameter, laterals of ½in diameter, which are inserted into the header pipe at intervals, and small diameter micro tubes or whiskers of 0.020 or 0.035 inch internal diameter inserted into the laterals. A thin wall (0.C6 in. thickness) lateral pipe having the same external diameter as standard ½ inch water pipe but with an internal diameter of 5/8 inch is being extruded for trickle use. A thin wall 3/8 inch pipe has also been introduced recently.

The small bore of the whisker restricts the rate at which water can leave the lateral, but the degree of restriction depends on the length of the whisker. A long whisker severely restricts the flow, but by shortening it, the flow rate can be increased. In this way, for any pressure, a wide range of delivery rates can be obtained.

As the reverse is also true, we have a simple means of accommodating varying pressures along the lateral to ensure a uniform delivery from each whisker in it. Undulating country can therefore be irrigated with a high degree of uniformity without the use of flow control valves or juggling with different pipe diameters; and long laterals need no longer result in poor watering at the ends farthest from the supply.

Alternative metering devices are being produced in various forms overseas. These are proprietary articles moulded from polypropylene and considerably more expensive than the extruded whisker. Despite claims that they are more effective this has not been proved and they lack the versatility of the whisker.

Laterals are connected to the header pipe by inserting them with a screwing action into holes drilled with a sharp wood bit. The hole should have a diameter 1/16 inch less than the outside diameter of the lateral. To ensure a good fit it is advisable to check the diameter of each batch of lateral pipe. Some variation does occur in the pipe from different manufacturers. A depth stop on the bit will prevent it penetrating the far side of the pipe.

Whisker insertion uses a slightly different technique, but again makes use of the elastic properties of polythene. A circular hole slightly less than the outside diameter of the whisker is punched in the lateral wall and expanded by the enlarged shank of the punch as it enters further.

The whisker can be inserted easily immediately after removing the punch, but it is soon gripped as the hole contracts. A hole may be temporarily enlarged to replace any whisker by slightly bending the lateral in the vicinity of the hole.

Header and lateral pipes are closed by doubling over the end 6 to 12 inches of pipe and either pushing on a short sleeve of slightly larger diameter pipe or by tying with string. An alternative method is to use wooden dowelling as bungs.

Pressures from 14 inches to over 60 feet head have been used in various installations but a 15 to 30 foot head is normally recommended. At very low pressures air locks can be troublesome on undulating ground but these can be displaced by running for a short initial period at a higher pressure.

MATERIAL COSTS

Approximate retail prices for the various components are as follows:

2 in standard polythene pipe	$17 per 100 ft
1½ in " " "	$12 per 100 ft
½ in " " "	$ 2-23 per 100 ft
5/8 in thin wall lateral pipe	$ 2-90 per 100 ft
3/8 in thin wall lateral pipe	$ 1-90 per 100 ft
0.20 and 0.035 in whisker	$ 4-80 per 1000 ft

One acre of orchard planted at a 20 ft x 20 ft tree spacing will cost approximately $75 for the within orchard materials. Blackcurrants at a 6ft row spacing on the same basis will cost $250 an acre.

CALIBRATION

Three New Zealand manufacturers are now producing whisker material in the 20 and 35 thousandths of an inch sizes. A semi high density polythene is being used. The external diameter is the same in both cases so only one punch is required.

Calibration charts showing discharge rates at different pressures for a range of whisker lengths have been produced by the New Zealand Agricultural Engineering Institute using one manufacturer's materials. These will not be exact for materials from other sources.

A wide range of pressures can be accommodated to give acceptable discharge rates. Examples of this are given in Table 1.

When cutting whisker material a razor sharp knife and a hard wooden block are recommended to prevent distortion and reduced discharge rates.

TABLE 1: Pressure/Length/Discharge Relationships for Nominal .020 and 0.035 Inch Whisker Materials.

Pressure ft.head	Discharge Required gallons per hour	Whisker diameter ins.	Whisker Length required ins.
[illegible]	0.1	.020	5
[illegible]	0.1	.020	30
5	0.25	.020	4½
5	0.25	.035	28
25	0.25	.020	26
	0.5	.020	2
10	0.5	.035	24
40	0.5	.020	16
[illegible]	1.0	.020	6
40	1.0	.035	47½

DESIGN

Trickle systems may be gravity fed from header tanks or reservoirs, or directly fed from artesian, pumped or high pressure mains supplies. Break pressure systems or pressure reducing valves may be required when using a high pressure source or trying to accommodate extreme gradient changes.

Like any other system of irrigation each trickle installation must be specificially designed for the particular set of conditions under which it will be working.

APPLICATION

Most commercial applications to date have been on berry, pip and stone fruit due to the semi-permanent nature of such crops and a relatively wide row spacing. Per acre pipe requirement is relatively low and once installed no further labour is needed apart from starting and stopping the flow. Other uses are developing steadily.

Fruit

Individual fruit trees are watered at a rate of 1 gallon per hour with a single 0.035 in.whisker fed from a lateral alongside each row. The discharge should be no nearer than two to three feet from the trunk so fungal or bacterial troubles are not encouraged.

Bush fruit in hedgerow plantings are supplied at lower rates with 0.020 in. whiskers inserted between every other bush. At the closer row spacing of strawberries laterals may be laid beneath the polythene mulch of every row. However, most growers now use one lateral between two rows and feed whiskers alternatively through the mulch on either side to discharge on top of the ridges between every other plant.

Pipe burial is recommended in semi and permanent installations to obviate ultra violet degradation and the risk of damage from vehicles and mowers. Header pipes should be six inches deep and laterals two to three inches. Except with strawberries the whiskers are laid along the lateral trench with no more than half an inch protruding above the soil surface.

(a) Commercial Installation

Following the installation of a one acre demonstration plot by the New Zealand Agricultural Engineering Institute in a North Canterbury orchard during the 1969/70 season, the grower installed trickle throughout 100 acres of his orchard the following year. Twelve thousand trees (apples, pears and peaches) can be watered from one bore with this permanent installation. Over 50 miles of pipe were required.

The area is subdivided into six sections each fed from a header tank supplied from the pump. In this way any or all of the blocks can be used without affecting the pressure or flow rate at any tree being watered.

This grower is extending his system to include a further 50 acres of new plantings this winter.

(b) Lincoln Orchard Trial

In a comparison between trickle, sprinkler and no irrigation on four varieties of apples at Lincoln College there was no difference in yield between trees irrigated by either system. The trees receiving no water suffered badly during the 1970/71 summer drought. Most of their leaves had been shed by late February and their fruit was little larger than plums. Water use with the trickle system was approximately 40% of that applied with the sprinklers. Clover grew normally between the sprinkled trees but dried off completely in the non-irrigated area. Trickle irrigated trees were each surrounded by a seven to eight foot diameter circle of lush clover with brown dried areas in between. Considerable worm activity was observed in these moist circles.

By instrumenting one of the trickled trees with six tensiometers it was possible to observe soil moisture status and water movement in the soil throughout the rooting zone. The frequency and duration of watering the trickled trees was based on the tensiometer readings.

During the month of February 1971 the evaporation rate from an open pan evaporimeter in the vicinity of the orchard averaged 22 points per day and there was no effective rainfall. Under these conditions a steady soil moisture level was maintained around the instrumented tree by watering at an average rate of 16 gallons per tree every four days. The trees were seven years old but not particularly well grown.

The trees in one of the trickle irrigated rows were each supplied with two whiskers so they received twice the normal application. Apart from an increase in the area of clover around each tree apple yield and quality and tree growth were no different from that of trees watered by only one whisker.

Two or more discharge points could be beneficial in very free draining soils to provide a larger volume of wetted soil in the rooting zone. In arid areas overseas where irrigation might have to provide the whole of trees' water requirements the use of trickle is not recommended in sandy soils beyond the first three years of growth. Under such conditions roots have been restricted to the discharge zone only so that tree stability is ultimately impaired.

(c) <u>Berry Fruit</u>

Blackcurrants, raspberries and strawberries have all responded well to trickle irrigation and produced large, good quality fruit. Cane growth has been excellent.

<u>Vegetables</u>

An acre of various vegetables has been grown at Lincoln using trickle during the past two seasons. The system worked well but the number of laterals required to completely cover the acre and the labour required for pipe movement where only a partial coverage was possible would not normally be acceptable on a commercial scale.

Two adjacent rows of established crop 20 inches apart could be watered quite satisfactorily by a single lateral fitted with 20 inch whiskers of 0.020 in. material spaced 24 inches apart. But some difficulty was experienced intially when trying to germinate rows of seeds in a very dry seed bed. The whiskers lay haphazardly and discharged in all directions so that it was impossible to produce a continuous wetted surface. This was later overcome by inserting the full length of each whisker into the lateral pipe and leaving only about half an inch protruding.

Moving laterals from one pair of rows to another presented no difficulty and the laterals themselves proved to be amenable to frequent handling.

Glasshouse Crops

The whisker trickle system has been installed in numerous comercial glasshouses for tomato, carnation and pot plant production. Cost has been appreciably less than conventional trickle systems using nozzles.

A most effective but very simple water needle to locate and control whisker discharge with potted or container grown plants has been developed by a Palmerston North nurseryman.

Lucerne

Trickle irrigation of lucerne would perhaps not be an economic proposition on a large scale under normal conditions, but it would enable a very limited low pressure supply to be utilised. The response to water applied in this way during severe summer drought in Canterbury has been dramatic. On a shallow loam overlying shingle a width of 6 to 9ft was stimulated into growth from a single lateral. With this knowledge, a harness of five 250 ft laterals each 6ft apart was made up so that a sixth of an acre could be watered at a time. The water supply was a 3/4 inch trough supply having a no flow pressure of 30 ft head and on supply delivering 2.9 gpm at 7 ft head. This was sufficient to apply the equivalent of an inch of water every 24 hours. By moving the harness daily an acre could be watered adequately in six days to cope with average summer consumption.

Trees and Shrubs

Ornamental and shelter belt trees and shrubs on farms and in gardens have been watered using the trickle system. Exceptional growth has been observed but the need for an adequate supply of nutrients along with the water became obvious on some specimens during prolonged dry periods. A small amount of complete NPK fertiliser sprinkled on the wetted zone quickly remedied the deficiency.

Trial Plots

Small plot irrigation trials are possible using trickle with no risk of spray drift affecting the accuracy of application.

Plot work using different moisture regimes was undertaken by the Plant Science and Horticultural Departments of Lincoln College on wheat, peas and tomatoes during the 1970/71 season.

EFFECT OF SOIL TYPE AND ROOTING DEPTH

Little is known about the spread of water in different New Zealand soil types but some work has been done, using a barium tracer in the irrigating water, and is continuing using a neutron scatter meter.

Under the clay loam conditions in the North Canterbury orchard the wetted profile beneath one whisker when run for 120 hours under drought conditions resembled an inverted cone 8 ft across and 3½ ft deep. In the shingle soils on the Ashley Dene farm at Lincoln College the cone never exceeded a 30 inch width. The rate of application will have some effect on the width of lateral spread.

An interesting observation was made when irrigating one plot of lucerne during the 1969/60 drought. The watering lateral with whiskers at a 2 ft interval crossed an area of dry prepared seed bed and a wide dried out grass verge before passing into a paddock of dormant lucerne. Three weeks after watering for 60 hours a 20 inch width of seedling weeds has appeared on the seed bed, a four foot wide strip of grass had been stimulated into growth on the grass verge and a green band 6 to 9 ft wide had appeared in the lucerne.

The spread of water was probably very little different in each condition but the differing rooting habits had enabled increasing widths of the wetted cone profile to be tapped.

WATER QUALITY

Clean water is essential for successful trickle irrigation. Filters are not necessarily an integral part of a system where a wholesome sand-free deep well source or town mains are available but must be considered so in most other cases. A simple low head loss filter using a foamed polyurethane element has been developed by the New Zealand Agricultural Engineering Institute for use with open water or other possibly contaminated sources. It is now in commercial production.

Troubles from dissolved salts and colloidal clays have not been reported within New Zealand so far but it is known that these present very real problems in some areas overseas. The high iron and calcium content of some New Zealand waters may impose some limitations on the use of trickle.

Nozzle blockages in conventional glasshouse trickle systems have sometimes occurred due to algae, fungi and bacteria growing in the flexible plasticised P.V.C. pipe used in the harness. Chemical additives in the water are used to effect a reasonable degree of control in commercial installations. Such growths are much less likely to occur in the polythene pipe used in the system under review. Polythene is relatively inert and the added black pigment inhibits most light transmission.

CROP FEEDING

The introduction of dilute nutrient solutions into whisker trickle systems is common practice in Israel and Australia and also in nozzle trickle systems in glasshouse installations in New Zealand. But there would not seem to be the same need for this on a field scale here where rainfall is usually sufficient to carry surface applied fertilisers into the soil and maintain them in solution.

The ability to apply supplementary nitrogenous fertilisers in solution would be beneficial with some crops.

CONCLUSIONS

The trickle system of irrigation will increase the potential area available for irrigation but its commercial use will generally be limited to high return crops and particularly those of a permanent or semi-permanent nature. It has already found favour with many fruit and glasshouse crop growers.

Good quality water is an essential and effective filtration will be a necessity in many installations. Chemical and colloidal impurities may limit its use in some areas.

Further work on the movement of water from a trickle discharge in different soils and the effect of this on rooting habit and growth is needed. The use of introduced fertiliser solutions should also be studied.