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NOTE

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IRRIGATION: Distribution Uniformity

Distribution Uniformity

Distribution uniformity describes how evenly irrigation is applied to the crop. When we irrigate we typically assume the irrigator applies water evenly across the whole paddock, and we assume this water soaks evenly into the soil. This is never perfectly true.

Distribution uniformity is assessed by setting collectors or catch cans out in the field, and by assessing the effects of pressure variations, spray interferences and other factors.

Distribution uniformity is a critical factor in determining the potential efficiency of any irrigation system. It is necessary to measure it in the field; it cannot be assessed by eye and varies from system to system, field to field and even event to event in some cases.

There are several ways of describing uniformity, but all compare the variability of application to the average application depth. A common approach is to report variation as the Distribution Uniformity of the lowest quartile (DUlq). This is calculated by comparing the average application depth measured across the whole system with the average of the lowest quarter of the depths measured.

Used by the USDA since the 1940's, the DUlq method is practical and economical for management. This way of measurement places a higher importance on under-watering than some alternative methods, yet still assumes that one eighth of the area may be under-irrigated.

An alternative way to describe evenness of distribution is the 'uniformity coefficient' (CU). The uniformity coefficient most often used is the Christiansen coefficient which was developed to describe how evenly a single sprinkler distributes water.

This method compares the absolute variation of the wettest and driest areas with the average.

With the Christiansen coefficient, over and under applications are treated the same. This is a good way to look at an individual sprinkler, especially if you want to look at putting a number of sprinklers together in a system.

However it does not recognise that under-watering is more likely to affect crop yields.

What is achievable?

In a perfect system (DU = 1.0) each plant would receive exactly the same amount of water.

Unfortunately irrigation is never perfect so the distribution of water is never absolutely uniform. The additional cost to install a perfect system would be more than any benefits gained, so a lesser uniformity is generally accepted.

Implications of non-uniformity

If a system has low uniformity, some areas can be over-watered while others do not receive enough. Both under and over watered areas will lose yield and have reduced crop quality. In the over-watered areas there is also increased risk of soil diseases, water will be wasted and valuable nutrients may be leached
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Accounting for Non- Uniformity

Uniformity should be considered when calculating irrigation depths to apply. If your average application just meets crop needs, half the orchard is over watered, and half is under-watered. A reasonable balance is to adjust the application so the average needs

of the lowest quarter are met. This means 1/8th of the crop is under watered (if only slightly), and 7/8ths over-watered.

Remember all the over-watering is wasted. It costs you money to apply and affects crop growth and health and leaches nutrients. The only way to minimise this wastage is to ensure your irrigation system applies water as uniformly as possible.

Causes of non-uniformity

The first cause of non-uniform watering is system design and installation. A poor system can never work efficiently.

The design of solid set systems is particularly critical, as any non-uniformity will be repeated at each irrigation. A tree under-watered once will be under-watered every time. In moving systems, such as travelling irrigators or hand moved pipes, the low or high applications may affect a different area each time, at least partially cancelling out the effect.

Uniformity can be enhanced by using alternate sets – setting the irrigator between adjacent positions at every other irrigation.

Spray or sprinkler systems can be affected by wind. The biggest problem is not blowing the water away or evaporating it, but causing excess dumps in some areas and not enough in others – again, non-uniformity and drainage losses.

The crop itself can also affect uniformity, particularly by disrupting sprinkler patterns. In orchard irrigation systems, under tree sprinklers have to contend with trunks and low branches, weeds and posts.

Overhead systems will have water intercepted by the canopy, and re-channelled, again putting too much in some places and not enough in others = non-uniformity.

Of the other causes of poor performance, application rates may be the most significant. If the application rate significantly exceeds the infiltration capacity of the soil, ponding and runoff will occur.

This will result in the redistribution of water at the surface and ultimately reduce the amount of water stored in the root zone.

Soil infiltration rates are typically variable even within a small field. If soil capping or compaction occurs, this seals the surface. Water cannot soak in so it runs off the higher areas to the low spots where soil becomes too wet.

Between the rows, the zones under wheel tracks will usually have lower infiltration rates, especially where tractors have been used in wet soil conditions. Ponding is evidence of mismatched application and infiltration rates. It is a sure sign of low irrigation efficiency.

The application rates of different systems vary enormously. Micro-irrigation systems that take a long time to apply water will generally allow the water to infiltrate adequately except in the most difficult situations.

Big guns have high instantaneous rates, but because they water each spot for a very short time the water can infiltrate if soils are in good condition. Centre pivots typically have very low instantaneous application rates at the centre, but can have very high rates at the end of the pivot.

SUMMARY

Distribution Uniformity is a critical factor in optimising irrigation and achieving high efficiencies.