Growers have found fluid fertilizers a better choice for delivering nutrients to many western U.S. soils due to the convenience of application through micro-sprinkler and drip irrigation systems. The loss of solid ammonium nitrate (due to terrorism concerns) has increased the availability and use of urea ammonium nitrate (UAN) in California in the past few years.

Major irrigation firms are focusing more upon the nutrient aspects of their products. Several companies have realized simply installing an extensive irrigation system does not guarantee the system will function properly or will ensure grower success with nutrient management.

One of the most important aspects of successfully using fluid fertilizers with irrigation systems is understanding the importance of proper water management. This water management can be considered in two forms: 1) the frequency of water application and the level of moisture in the soil, and 2) the overall quality of the water and ways to improve the water quality for improved irrigation efficiency and water management.

**Water needs**

*Application frequency.* A common problem is over-application of water with micro-sprinkler and drip irrigation systems. It is important for growers to use various tools to predict the appropriate amount of water needed by the crop. In California, this means using the California Irrigation Management Information System (CIMIS) through the state-maintained website (http://www.cimis.water.ca.gov/cimis/data.jsp). The important thing about using this information is the hourly update of data from various weather stations around the state. These data are based upon accurate Evapotranspiration (ET) values. In semi-arid and arid regions where the soil surface is dry, it is often tempting to irrigate when the sub-soil moisture is adequate. Using ET values ensures excess moisture will not exist. Over-irrigation can lead to excessive accumulation of soluble iron, manganese and hydrogen sulfide, plus encourage more disease organisms.
**Quality considerations.** A major problem of water quality exists in the Western U.S. where snow melt water is used. A similar problem can occur anywhere rainwater is collected in reservoirs. The problem is water that’s too pure. Such water with a low electrolyte level allows the clay and humus particles to swell with water, leaving the soil pores near the soil surface plugged. Correction for the problem is to add sufficient gypsum to bring the EC of the treated water to above 0.3 mmhos/cm. Gypsum should be treated with acid to ensure pH is about 6.5.

Another water problem is the presence of calcium carbonate. Calcium and bicarbonate ions will react when the water dries in the soil pores, forming insoluble lime inside existing soil pores. Over time, these pores become clogged and can no longer transmit water. Adding some acid to the lime will correct the problem. Ideally, water pH should be reduced to 6.5.

A third problem may exist, depending upon the fluid fertilizer injected into the irrigation system. This problem occurs from injecting potassium (K) fertilizers and with ammonium (NH₄⁺) and less problems with urea injection. The urea fertilizer will convert into ammonium carbonate when it contacts the urease enzyme in the soil as the urea treated water moves into the soil.

The major problem is due to the presence of a high concentration of monovalent cations surrounding the drip emitters and micro-sprinklers. Potassium, ammonium, and sodium ions act in a similar manner. Water penetration is strongly reduced along with reduced aeration and root penetration. This problem is worse the lower the electrical conductivity (EC) of the irrigation water. This problem can be alleviated by hard water (containing an abundance of calcium and magnesium ions) helping to push these monovalent potassium and ammonium ions away from the drip emitter. Injection of gypsum will help. Injection of calcium nitrate or calcium ammonium nitrate solutions will provide sufficient calcium to move the potassium or ammonium farther away from the drip emitters.

**Special considerations.** A special consideration occurs for buried drip irrigation. In this case, emitters must have a slow release herbicide embedded into the plastic of the emitter or a herbicide must be injected to prevent root penetration into the drip lines. This is particularly important for buried drip lines used for prolonged crop growth.

A common problem with drip irrigation is the failure of the grower to ensure the drip emitters and fan jets of micro-sprinkler irrigation are maintained in an open and fully operational condition. This is a particularly serious problem where permanent crops may result in the death of a full tree before the grower becomes aware of this problem. Using acid injection is the best way to overcome this problem in most systems.

Reduced or under-irrigation can create a problem with salt intrusion. The normal drip irrigation system results in a wetting pattern allowing the water and salts to move downward and outward from the drip zone. However, with under-irrigation, insufficient water is applied and salt at the edge of the wetted pattern can enter into the root zone, harming crop growth on soils lacking adequate drainage.

**Water-use efficiency**

**Advantages.** Obviously, drip and micro-sprinkler irrigation systems use less water because the total mass of soil contacted by the water is usually only about one-tenth of the total compared to conventional furrow or sprinkler-irrigated systems. Efficiency generally depends on the overall management provided by the grower. The application of fluid fertilizers through a micro-sprinkler or drip irrigation system can be no more efficient than the application of the water itself.

**Watching EC and ET.** Growers who fail to treat their water for problems of EC conditions risk surface water runoff and soil erosion of flat land. Growers must account carefully for ET of the crop to assure optimum water-use efficiency.

**Field workers** must be responsible for making appropriate connections, changing fertilizer injection tanks, and adjusting for appropriate flow rate.

**Nutrient-use efficiency**

**Water application.** Water can be distributed more evenly throughout the plant root zone in a pattern more similar to the actual pattern of normal root growth. This greatly enhances the potential for deeper root growth and greater use of the native nutrient conditions in the subsoil. However, growers must realize this and compensate by applying replacement nutrients. Otherwise, the deeper subsoil can be effectively mined by this greater root exploration, resulting in reduced yield over time.

**Fertilizer injection.** Less energy is required in applying the fertilizer. This becomes a major savings in tractor fuel expense and increasingly a savings in time and labor. Many micro-sprinkler and drip irrigation systems have become automated with sensing devices to determine the amount of water being applied and the amount of fertilizer being injected.
on a continuous basis, frequently
with solar collectors in the field to
power the monitoring devices.

New multiple head fertilizer
injectors allow as many as four
different fertilizers to be applied
by a single injection device, simul-
taneously using different injection
rates for each fertilizer.

It is critical to dedicate a specific
fertilizer to its own tank location
and injection port on an irrigation
line.

**Good design.** The unexpected
benefit of this is seen in recent
micro-sprinkler and drip irrigation
systems. This is explained by
realizing a well-designed sys-
tem first provides patterns most
closely matching the ideal rooting
pattern of normal crops. Second,
water is being applied usually on
a daily or every-other-day basis.
This maintains the soil root zone
in a condition near or slightly
above the normal field capac-
ity moisture condition, which is
known to optimize plant growth.

**Keeping moist.** Normally, with
furrow and sprinkler irrigation on a
weekly or every-other-week basis,
the soil dries out somewhat be-
tween irrigations. This process of
soil drying results in an increase
in soil moisture tension or suction
in the root zone. This requires
the plants to exert more energy
for water absorption via the pas-
sive process of transpiration out
of the plant leaves. This reduces
the overall amount of water reach-
ing the plant during these periods
between irrigations.

**Phosphate levels.**
With micro-sprinkler and
drip irrigation, plus grow-
ers exercising superior
management, crop roots
are continually at op-
timum moisture. This
means phosphate avail-
ability is maintained at
optimum levels in the
solution, thus optimizing
plant growth and crop
production.

These results are
usually amplified by
constant spoon feeding
of ammonium polyphos-
phate fertilizer at the rate
of about one part per
million of phosphorus in
the irrigation water. This
level is below the solubil-
ity limit thereby allowing
free movement of this
phosphate through the
irrigation system. This
level ensures a higher
level of phosphate is
maintained in the soil
solution throughout the
entire plant root zone.

Consequently, growers
using micro-sprinkler and drip irri-
gation have noted yield increases
on the order of 15 to 20 percent
compared to similar crops pro-
duced with conventional furrow
or sprinkler irrigation with normal
field drying between applications.
In some instances, growers have
reported both increased yield and
improved crop quality as a result
of optimum fertilization.

Another unexpected discov-
ery is the fact most growers and
researchers have not realized the
full extent to which even slight
moisture stress (via increase soil
moisture tension) decreases the
plant-available phosphate level.
Because moisture and phosphate
are maintained at near optimum
levels with both drip and micro-
sprinkler systems, the crop is no
longer controlled by limited phos-
phate availability.

In addition, because the crop
is growing more effectively with
a higher level of phosphate pro-
moting more growth, the plant
is able to use almost all other
nutrients efficiently. The result is
the plant tissue of micro-sprinkler
and drip irrigated crops will have
a much higher concentration of
other nutrients in the plant tissue
plus requiring the grower to make
special adjustments to total appli-
cation amounts.

Growers who have benefited
from this process may not fully
understand why these systems
operate as they do, but they will
fully appreciate the profits gained
by investing in them, as well as
the fluid fertilizers they inject on a
continuous basis throughout the
crop growing season.

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