APPLICATION OF PLANT NUTRIENTS THROUGH IRRIGATION WATER

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ABSTRACT

The application of plant nutrients through irrigation water is one of the most efficient methods for fertilizer application to enhance crop production and reduce or eliminate potential environmental problems related to direct soil surface fertilizer applications. Stable clear liquid fertilizers are usually preferred for fertilization as compared to solid materials which must be solubilized before use, especially for drip irrigation systems. Tessenderlo Kerley produces a number of clear liquid products which have proven to be useful for fertigation. One of these products KTS (potassium thiosulfate) has been evaluated by several researchers for use in sprinkler and drip irrigation systems.

INTRODUCTION

The practice of applying plant nutrients through irrigation systems, known as fertigation has been used since the 1930's. Anhydrous ammonia was applied through irrigation water in California before liquid fertilizers became available (Ransdell, 1968). Fertigation began to expand rapidly in the 1950's when nonpressurized sources of liquid nitrogen became available.

Today, the application of plant nutrients through irrigation water is one of the most efficient methods for fertilizer applications to enhance crop production and reduce or eliminate potential environment problems such as runoff from broadcast surface applied fertilizers, ground water nitrate contamination from single nitrogen applications, etc.

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FERTILIZER APPLICATIONS

In order to avoid clogging of irrigation systems, fertilizers must be very soluble and compatible with the irrigation water. Stable liquid fertilizers have proven to be well suited for application through all types of irrigation systems. Solid fertilizers are widely used, but must be solubilized without leaving a residue of clay or wax. Fertilizers vary greatly in their solubility (Burt et al, 1995). These solubilities are illustrated in Table 1.

Clear liquid fertilizers are well suited for application through irrigation systems, especially low volume systems. These products can be metered into irrigation systems with a minimum of equipment and save time since the nutrients are already in a soluble form and ready to use. Some products currently being used in low volume systems include urea-ammonium nitrate solutions, phosphoric acid and potassium thiosulfate.

SPECIALTY LIQUID FERTILIZER PRODUCTS

Tessenderlo Kerley currently is the largest manufacturer of specialty liquid fertilizers in the world. Since the development of ammonium polysulfide - ammonium hydroxide and ammonium thiosulfate in the 1950's the specialty product line has continued to expand through new product development and acquations (Clapp, 1998). In addition to being the largest manufacturer of ammonium thiosulfate (THIO-SUL) in the world, Tessenderlo Kerley also developed and is the largest manufacturer of potassium thiosulfate (KTS).

The company purchased the control release triazone nitrogen technology (Clapp and Purham, 1991) from the Accadian Corporation in 1993. This form of nitrogen (urea-triazone) is used in the formulation of several clear liquid products used for foliar and fertigation applications. Some of these products are summarized including their characteristics in Table 2.

These products have been evaluated in several field trials for application via irrigation waters. Zink (1998) reported a significant increase in potato yields when potassium thiosulfate (KTS) was added through a center pivot irrigation system in the San Luis Valley of Colorado. His evaluation included the addition of KTS to the recommended rate of soil applied potassium as potassium chloride over a three year period. These results are summarized in Table 3 and show that the addition of KTS applied through the overhead irrigation water increased potato yields by an average of 12% over the three year period.

A similar study was initiated in 1997 on cotton in Missouri (G. Stevens, unpublished data) with KTS being applied through overhead irrigation water. Results from this preliminary study are summarized in Table 4. Cotton yields were increased when all or part of the potassium was applied through sprinkler irrigation as compared to a soil application.

Three potassium sources were evaluated through drip irrigation for apple production in New York (W.C. Stiles, unpublished data, 1995). Results are summarized in Table 5.

A drip fertigation trial was conducted in North Carolina (D.C. Sanders, unpublished data, 1997) to evaluate nitrogen and potassium sources for tomato production. These treatments and results are summarized in Table 6. The clear liquid products, TRISERT - CB and KTS worked very well in this system and gave a higher yield than other products which first had to be solubilized.

SUMMARY

The application of plant nutrients through irrigation water is a standard method to enhance crop production in many commercial operations. The use of clear liquid fertilizer sources eliminate the problem of dissolving solid material prior to injection into irrigation water. For drip irrigation systems, solid materials may result in plugged emitters unless completely dissolved.

New clear liquid products such as KTS (potassium thiosulfate) have proven to be an effective and easy to use source of plant nutrients for fertigation.

Table 1. SOLUBILITY OF FERTILIZER MATERIALS

	Grade	Solubility gm/100ml
Nitrogen Fertilizers		
Ammonium Nitrate	34-0-0	18.3
Ammonium Polysulfide	20-0-0	high
Ammonium Sulfate	21-0-0	70.6
Ammonium Thiosulfate	12-0-0	v. high
Anhydrous Ammonia	82-0-0	38.0
Aqua Ammonia	20-0-0	high
Calcium Nitrate	15.5-0-0	121.2
Urea	46-0-0	100.0
Urea Sulfuric Acid	28-0-0	high
Urea Ammonium Nitrate	32-0-0	high
Phosphate Fertilizers		
Ammonium Phosphate	8-24-0	moderate
Ammonium Polyphosphate	10-34-0	high
Ammonium Polyphosphate	11-37-0	high
Phosphoric Acid, green	0-52-0	45.7
Phosphoric Acid, white	0-24-0	45.7
Potash Fertilizer		
Potassium Chloride	0-0-60	34.7
Potassium Nitrate	13-0-44	13.3
Potassium Sulfate	0-0-50	12
Potassium Thiosulfate	0-0-25-17S	v. high
Monobasic Potassium	0-52-34	33

Micronutrients			
Borax	11%	B	2.10
Boric Acid	17.5%	B	6.35
Solubor	20%	B	22
Copper Sulfate (acidified)	25%	Cu	31.6
Cupric Chloride (acidified)			71
Gypsum	23%	Ca	0.241
Iron Sulfate (acidified)	20%	Fe	15.65
Magnesium Sulfate	9.67%		71
Manganese Sulfate (acidified)	27%	Mn	105.3
Ammonium Molybdate	54%	Mo	43
Zinc Sulfate	36%	Zn	96.5
Zinc Chelate	5%-14%	Zn	v. sol.
Manganese Chelate	5%-12%	Mn	v. sol.
Iron Chelate	4%-14	Fe	v. sol.
Copper Chelate	5%-14%	Cu	v. sol.
Zinc Lignosulfonate	6%	Zn	v. sol.
Manganese Lignosulfonate	5%-14%	Cu	v. sol.
Iron Lignosulfonate	6%	Fe	v. sol.
Copper Lignosulfonate	6%	Cu	v. sol.
Lime Sulfur			high
Sulfuric Acid	95%		v. high

Table 2. TYPICAL PROPERTIES OF TESSENDERLO KERLEY'S LIQUID FERTILIZER PRODUCTS

Product Trade Name	Grade	% of Total N as SRN	Spec. Grav. @15°C	gms. Total N Per Liter @15°C	gms.Other Plant Nutrient Per Liter @15°C	Salting Out Temp °C	Typical pH
KTS®	0-0-25-17S	0	1.460	0	360K2O,252S	- 9	7.0-8.2
FORMOLENE-PLUS®	30-0-0	60	1.285	385	0	- 18	9.5
N-SURE®	28-0-0	72	1.287	360	0	- 18	9.5
N-SURE® -LITE	30-0-0	50	1.261	378	0	- 18	9.5
THIO-SUL®	12-0-0-26S	0	1.327	160	344S	- 7	7.2-8.0
TRISERT®	13-3-4	50	1.179	156	36 P2O5,48 K2O	- 7	9.5
TRISERT® -CB	26-0-0.5B	33	1.223	324	6B	- 18	8.7
TRISERT® -KS	15-0-12-8S	60	1.357	204	168 K2O,108S	- 18	10.3
TRISERT® -KSB	26-0-5-3S-0.3B	33	1.306	336	65 K2O,40S,4B	- 18	9.5
TRISERT® -NB	26-0-0	33		316	0	- 18	8.7
TRISERT® -VG	9-6-8-0.1 FE-0.05ZN-0.05Mn-0.05Cu-0.02B-0.0005Mo	33	1.224	110	72 P2O5,96 K2O	- 10	9.9
TRISERT®-VGN	9-6-8	33	1.224	108	72 P2O5,96K2O	- 10	9.7
NFE™	16-0-0-4Fe	0	1.330	214	53Fe	- 17	7.5
NMG™	14-0-0-4Mg	0	1.345	188	54Mg	- 8	6
NZN™	15-0-0-5Zn	0	1.136	198	66ZN	- 8	4

Table 3. POTATO RESPONSE TO KTS VIA IRRIGATION WATER

Treatment	Yield - T/ha 1995	1996	1997	Avg.
No K_2O applied	-	44.6	31.9	-
Recommended K_2O	23.7	49.4	34.9	36.0
Recommended K_2O + Fertigation with KTS	26.7	52.2	42.4	40.4
LSD .05	2.4	5.0	4.9	4.1

Table 4. COTTON RESPONSE TO K FERTIGATION

Treatment[a] -K_2O kg/ha		Yield
Soil	Sprinkler	kg/ha
0	0	1061
39	0	1056
19.5	19.5[b]	1116
0	19.5[b]	1176
0	19.5[c]	1112

a KCl used for soil application, KTS used for application via overhead irrigation.
b One application at first bloom.
c Two applications (first bloom and two weeks later).

Table 5. APPLE RESPONSE TO K SOURCES APPLIED VIA DRIP IRRIGATION

	Tissue %K				
K Source[a]	June	July	Aug.	Sept.	Oct.
KTS	1.68	1.54	1.27	1.06	.99
K_2SO_4	1.59	1.44	1.24	1.06	.92
KCl	1.54	1.46	1.26	1.01	.90

a Five monthly applications (May-Sept.) at 13 kg/ha K_2O

Table 6. TOMATO RESPONSE TO NITROGEN AND POTASSIUM SOURCES VIA DRIP IRRIGATION

Treatment [a]		Yield - T/ha		%
N-Source	K-Source	Total	Marketable	Cull
$CaNO_3$	KCl	43.5	33.8	18
$CaNO_3$	KNO_3	44.4	31.6	27
$CaNO_3$	KTS	45.7	33.4	23
T-CB[b]	KTS	47.5	38.1	12

a N and K_2O applied during growing season at 78 and 157 kg/ha, respectively.
b TRISERT - CB (26-0-0-5B)

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