Ultrasol™ Magnum P44
Product Manual

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Foreword

SQM is a major supplier of specialty plant nutrition and related services to distributors and growers around the world.

As part of its commitment to the agricultural community, the company has now developed the Ultrasol™ Magnum P44 Product Manual. Like the Crop Kits, this Product Manual compiles the results of yearlong research and development activities, as well as the practical experiences of the company's specialists from around the world, in order to provide comprehensive Specialty Plant Nutrition product management information to SQM's distributors, agronomists, growers and farmers.

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Introduction

This Ultrasol™ Magnum P44 Product Manual is an updated version of the original Kemira Magnum P44 manual. The information has been adapted to SQM branding and lay out, and includes the latest scientific insig ts and trial reports.

The target of this Ultrasol™ Magnum P44 Product Manual is to provide comprehensive Ultrasol™ Magnum P44 product management information to SQM's business partners such as the fertiliser industry, distributors, agronomists and growers.

Chapter 1 describes its technical aspects, such as chemical information, safety data, handling and storage, production process, solubility, crystal size distribution, sieve analysis, pH effects and bicarbonate neutralizing capacity, electrical conductivity, water hardness, and its main uses, many times compared to other major phosphorous sources like MAP, MKP and phosphoric acid.

An extensive overview of trial work, with respect to fertigation, foliar and manual applications, dipping, earliness, pH lowering effect in the soil, and reduced N-volatilization is presented in Chapter 2.

Marketing and product management is covered in Chapter 3 and comprises a press release of the take-over of the UP plant in Dubai from Kemira by SQM, a list of frequently asked questions and their respective answers, product positioning, unique selling propositions and sales arguments, economical calculation and benefit .

A literature overview of Ultrasol™ Magnum P44 with applications in plant nutrition, fertiliser production, animal nutrition, hygiene, in mixes with plant growth regulators, silage and other applications is presented in Chapter 4.

In Chapter 5 a comprehensive overview is given of the main urea phosphate patents as held by OMS Investments Inc (Scotts), Kemira and the Regents of the University of California. This chapter also features an overview of the patent-free technologies for the production of UP based fertilisers. Finally, Appendix 1 deals with the Ultrasol™ Magnum Flex Concept, whereas Appendix 2 describes the advantages and the benefits of the Ult asol™ Magnum P44 Disk.

Note on booklet value-expression convention:
(.) Period: indicates thousands.
(,) Comma: demarcates the place of the decimal.
The number 1.500,5, stated in words, is
"One thousand fi e hundred and fi e tenths".

1 Technical Data

1.1 Composition/Information on Ingredients

Chemical Name	Urea Phosphate
CAS Nº	4861 – 19 – 2
EINECS Nº	225 – 464 – 3
Molecular Weight	158,0 gram
Formula	$(NH_2)_2CO.H_3PO_4$
Content	98% min

1.1.1 Manufacturer and Supplier

Manufacturer and Supplier	SQM Dubai - FZCO
Address	PO BOX 18222 Dubai – UAE
Telephone	(971 4) 883 8506
Fax	(971 4) 883 8507
Emergency Number	+1 (703) 527 3887 (CHEMTREC International)

1.1.2 Application

Agriculture and horticulture fertiliser for fertigation, foliar application, band application and as a raw material for water-soluble NPK production.

Also to be used as a sterilizing agent and cleaner, as an ingredient in animal feeds and as a fi e retarding agent in specialty paints and coatings.

1.1.3 Chemical Properties

Chemical Name	Urea Phosphate
Chemical Formula	$CO\ (NH_2)_2.H_3PO_4$
Total Nitrogen (%)	min. 17,5 max. 17,7
Total Potassium (K_2O)	-
Total Phosphorous Pentoxide (P_2O_5), soluble in water (%)	min. 44,0 max. 44,8
Total Phosphorous (P), soluble in water (%)	min. 19,2 max. 19,6
Water-soluble in 2% solution (%)	99,8
Water-insoluble in 2% solution (%)	0,2
Moisture (%)	< 0,2
pH of 1,0 % aqueous solution	1,8
pH of 0,05% aqueous solution	2,7
Solubility in water (g per 100 ml) at 10 °C at 20 °C	 79 96

1.1.4 Physical Properties

Form and odour	Crystalline, odourless powder
Colour	White
Bulk Density (kg/l)	0,98
Melting point (°C)	117
Boiling Point	not available
Flash Point	not applicable
Flammability	no data available
Auto ignition temperature	does not ignite
Explosion limits	not applicable
Molecular weight (g)	158,0

Particle Size Distribution

Size (mm)	Cumulative Oversize (%)
+ 1,00	8,5
+ 0,80	14,9
+ 0,50	49,9
+ 0,25	89,0
+ 0,15	98,1
< 0,15	1,9

pH Values and Electrical Conductivity

pH Values		Electrical Conductivity (25 °C)	
0,05 % water solution	pH 2,7	0,25 g/l	0,31 mS/cm
10% water solution	pH 2,0	0,5 g/l	0,62 mS/cm
30% water solution	pH 1,0	1,0 g/l	1,22 mS/cm
		2,0 g/l	2,04 mS/cm

1.2 Safety Data

1.2.1 Hazards Identific tion

Potential Health Effects	
Inhalation	Inhalation of dust may irritate the mucous membranes and respiratory tract.
Ingestion	May be harmful.
Skin Contact	May cause irritation and burns.
Eye Contact	May cause irritation and burns.

1.2.2 First Aid Measures

Specific easures	
Inhalation	Remove to fresh air. Get medical attention for any breathing difficu y.
Ingestion	Rinsemouthwithwateranddrinkplenty of water. Never administer anything by mouth (oral) to an unconscious person. Seek medical attention.
Skin Contact	Wash with copious amounts of water. Removecontaminatedclothing.Contact a physician if necessary.
Eye Contact	Flush eyes with plenty of water for 15 minutes, lifting lower and upper eyelids occasionally. Contact an ophthalmologist.

1.2.3 Fire-Fighting Measures

Fire	Non - flammabl .
Fire Extinguishing Media	Any means suitable for extinguishing surrounding fi e.
Special Protective Equipment	Useselfcontainedbreathingapparatus. Wear protective clothing. The product emits toxic fumes under fi e conditions (ammonia and carbon dioxide).

1.2.4 Accidental Release Measures

Personal Precautions	Ventilate the area. Take precautions to minimize contact with the substance. Use personal protective equipment (See 1.2.5 Exposure Controls/Personal Protection).
Environmental Precautions	Do not discharge into drains. Avoid surface and ground water contamination.
Methods for Cleaning Up/Taking Up	Pick up the dry product mechanically and store in suitable containers for recovery or disposal. Avoid raising dust.

1.2.5 Exposure Controls/Personal Protection

Exposure Limit Values	
Suggested according to US Regulations	15 mg/m^3 (total dust) 5 mg/m^3 (respirable fraction)
Non-regulated according to European regulations.	

Personal Protective Equipment	
Respiratory	Dust mask if necessary (fil er type P2).
Eyes	Safety goggles required all the time.
Hands	Nitrile rubber gloves, over 0,11 mm thickness, >480 minutes breakthrough time.

1.2.6 Toxicological Information

Oral Rat Toxicity (LD50)	5.840 mg/kg (Source: U.S. National Library of Medicine).

To the best of our knowledge, the toxicological properties of this substance have not been deeper investigated.

1.3 Handling and Storage

Handling	
Special Procedures	None.
Safe Handling Procedures	Minimize dust generation. Avoid contact with eyes and skin. Incompatible with bases due to acid behaviour when dissolved in water.
Special Advices	None.
Storage	
Special Requirements	Reseal carefully any opened packaging and set upright to avoid leakages. Keep the product in the original packaging.
Storage Conditions	Keep tightly closed, in a well ventilated and cool place.

1.3.1 Transport, Storage, Handling and Use

Rail & Road (ADR/IRD) – Sea (IMDG Code) – Air (IATA)	
Proper Shipping Name	Corrosive Solid, n.o.s. (Urea Phosphate).
UN Number	1759
Class	8
Packaging Group	II
Hazard Label	Corrosive.
Transport	Ensure that the means of transport is clean before loading the product.
Storage	To prevent caking, buildings used for storage should be dry or product should be kept in closed plastic packagings. It is advisable to store in a warehouse pallets maximum two high and big bags maximum one high in order to reduce the risk of caking. Caking does not have effect on the amount of insolubles.
Corrosion	Product is corrosive. It decomposes to phosphoric acid and urea when dissolved in water. Avoid unnecessary exposure to the atmosphere to prevent moisture pick-up.
Use	Use in accordance with manufacturer's advice. DO NOT exceed maximum recommendations.

1.3.2 Stability and Reactivity

Stability	Stable under normal storage and temperature conditions.
Materials and Conditions to Avoid	Contact with strong oxidizing agents, reducing agents, bases. Avoid high temperatures.
Hazardous Decomposition Products	Carbon monoxide, carbon dioxide, nitrogen oxides, ammonia.

1.4 Other

1.4.1 General Ecological Information

- Do not discharge into drains and water or public depositories.
- No ecotoxicological data available.
- Potentially harmful to aquatic organisms due to pH lowering of water.
- Bioaccumulation not expected, since it produces urea and phosphoric acid in water.

1.4.2 Spillage

- Spillage should be cleaned up promptly.
- Material should be swept up and placed in an appropriately labelled container.
- Depending on the degree of contamination, dispose by use on farm by spreading thinly on open ground or deliver to an authorized waste facility.
- Take care to avoid the contamination of watercourses and drains. Inform appropriate water authority in case of accidental watercourse contamination.

1.4.3 Disposal Considerations

Residues	Allocation of a waste code number, according to the European Waste Catalogue (EWC), should be carried out in agreement with the regional waste disposal company.
Empty Packaging	Empty containers may be reused after appropriate cleansing. Packaging that cannot be cleaned should be disposed in agreement with the regional waste disposal company.

1.4.4 Regulatory Information

Labeling according to EC Directives		
Hazard Symbol	C	Corrosive.
R-phrases	34	Causes burns (*).
S-phrases	2	Keep out of reach of children.
	26	In case of contact with eyes, rinseimmediatelywithplentyof water and seek medical advice.
	39	Wear eye/face protection.
	45	In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).

(*) Main primary risk is irritation. More sensitive individuals may suffer burns.

1.5 Ultrasol™ Magnum P44 Production Process Description

1.5.1 General

SQM's Ultrasol™ Magnum P44 production process enables us to produce fully water-soluble Ultrasol™ Magnum P44 from fertiliser grade urea and phosphoric acid.

The capacity of the plant in Dubai is 30.000 tonnes Ultrasol™ Magnum P44 per year.

1.5.2 Process

Urea, delivered mainly in bags, will be emptied into the hopper of the reactor feeder. Phosphoric acid can be shipped from Europe, Africa or Jordan.

The storage capacity of the two phosphoric acid tanks is 2.000 m^3 each.
Acid from the storage tanks is pumped into the reactors.

The digestion of the raw materials will happen in reactors.
The reaction is:

$(NH_2)_2CO$	+	H_3PO_4	$\longrightarrow$	$(NH_2)_2CO.H_3PO_4$
Urea		Phosphoric Acid		Urea Phosphate

After the reaction, the crystallization of the product will take place in a large crystallizer. Urea phosphate crystallizes in a very pure form, leaving the impurities of fertiliser grade phosphoric acid in the mother liquid.

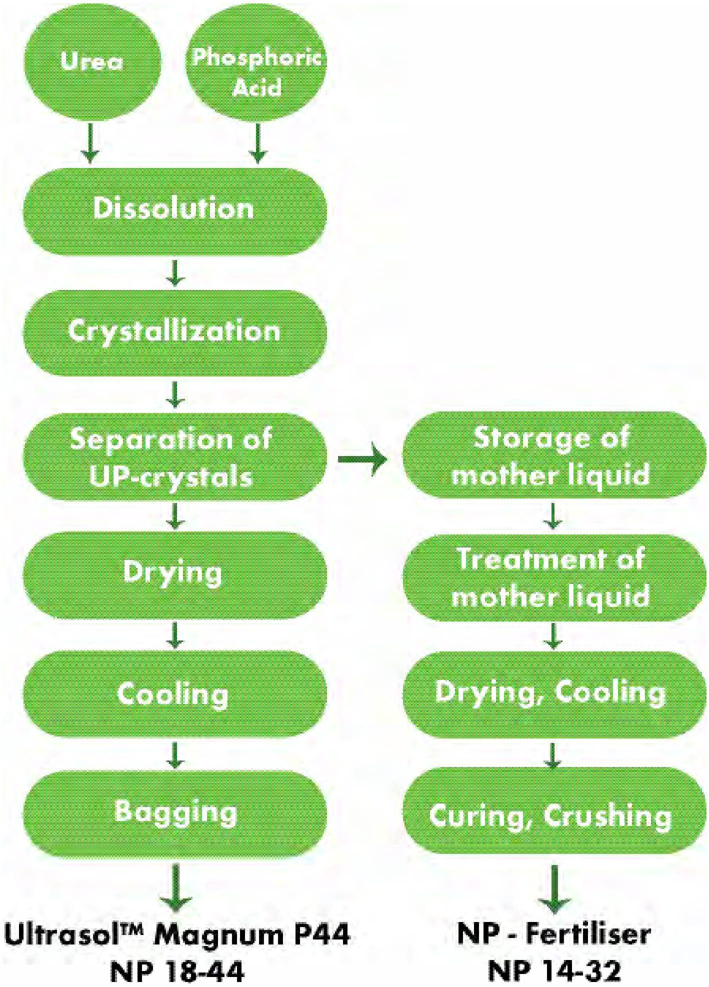
Ultrasol™ Magnum P44 crystals will be separated from the mother liquid in the centrifuge. Internal recycling of mother liquid from crystal separation will improve the efficie y of use of the raw materials.

The moist crystal cake is dried in a hot air drum dryer and then cooled.

The product will be delivered bagged in 25 kg bags on 1.200 kg pallets (container) or on 1.250 kg pallets (truck) or in 1.000 kg big bags.

Because the various impurities will accumulate in the mother liquid, part of it is removed continuously into by-product handling.

Motherliquidistreatedinreactorsintourea-ammoniumphosphatemixture,whichisdried, stored and bagged to be sold as solid NP-fertiliser with a typical analysis of 14% N and 32% P_2O_5. SQM holds the patent for this process.



1.6 Solubility Rate Testing of Various Fertilisers

1.6.1 Solubility Rate Testing

The solubility rate of various P-fertilisers was measured by the percentage of undissolved crystals that stayed in a solution after dissolution. It was tested as follows:
1. Fertiliser (1 part) is added to ion - exchanged water (9 parts) at 25 °C.
2. The slurry is stirred gently to keep the largest crystals off the bot om.
3. The undissolved crystals are fil ered off th ough a 125 µm screen.
4. The amount of dried (105 °C) residue is related to the time.

The percentage of undissolved crystals of various P-fertilisers is shown in Table 1 and Figures 1 and 2.

Table 1. The percentage of undissolved crystals from 10 to 180 seconds after dissolution of various P-fertilisers.

Time, seconds	10	30	60	120	180
Time, minutes	0,17	0,5	1	2	3
Ultrasol™ Magnum P44					
undissolved %	0,74	0,09	0,06		
undissolved %	1,14	0,43			
undissolved %	2,10	0,43	0,06		
average %	1,33	0,32	0,06		
MAP					
undissolved %	26,0	9,4	2,1	0,44	0,02
undissolved %	25,4	7,3	5,3	0,30	0,05
undissolved %	20,4	9,6	3,6	0,29	0,04
average %	23,9	8,8	3,6	0,34	0,03
MKP-1					
undissolved %	19,0	3,1	0,24	0,05	
undissolved %	20,5	4,6	0,39	0,07	
average %	19,8	3,9	0,32	0,06	
MKP-2					
undissolved %	16,5	10,7	1,1	0,10	
undissolved %	17,4	9,1	2,2	0,08	
average %	17,0	9,9	1,7	0,09	

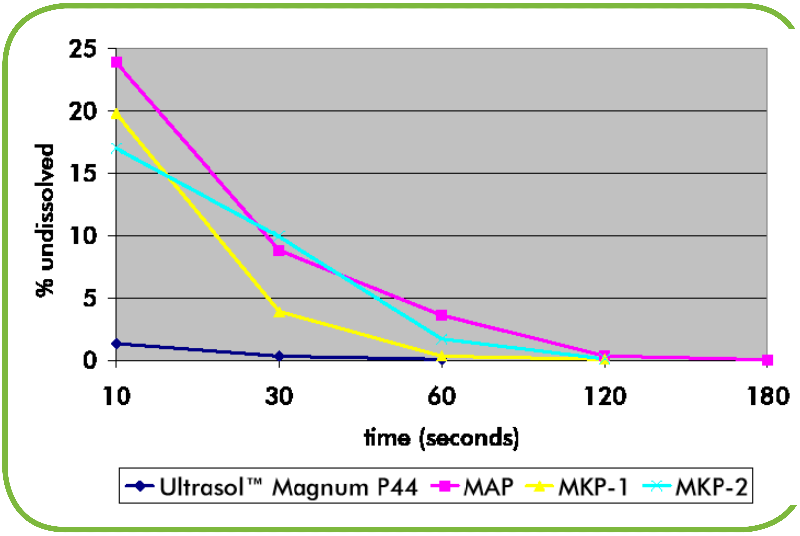


Figure 1. The percentage of undissolved crystals from 10 to 180 seconds after dissolution of various P-fertilisers at 25 °C.

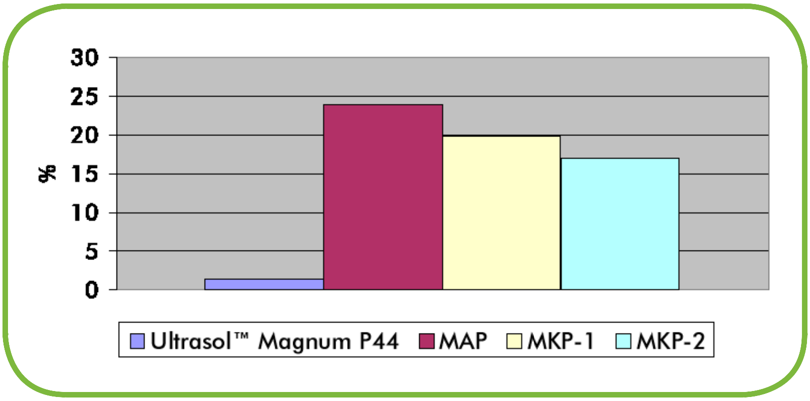


Figure 2. The percentage of undissolved crystals 10 seconds after dissolution of various P-fertilisers.

1.6.2 Conclusions

Ultrasol™ Magnum P44 is a very fast dissolving salt.

The largest crystals (1 mm) settle with a speed of 10 cm/s. This means, that in a 1 metre high tank without agitation the coarse part of the fertilisers will fall to the bottom in 10 seconds.

Crystals on the bottom dissolve very slowly. Such problems have occurred with e.g. the MKP-2 product.

A short stirring (2 minutes) is enough to dissolve all of the tested fertilisers completely.

The type of fertiliser is also of importance. Ultrasol™ Magnum P44 dissolves much faster than MAP and MKP. The Ultrasol™ Magnum P44 and MKP-2 has similar crystal size distribution, but the time for complete dissolution is much longer for MKP (also see Chapter 1.7).

1.7 Crystal Size Distribution (CSD) of the Compared Fertilisers

1.7.1 CSD of the Compared Fertilisers

Table 2. CSD of various P-fertilisers.

	Cumulative oversize (%)			
Sieve size (µm)	Ultrasol™ Magnum P44	MAP	MKP-1	MKP-2
2.000		0,2		
1.000	8,5	9,9		
800	14,9			
710				6,2
560			3,6	17,1
500	49,9	44,4		
450			15,4	36,9
355			33,2	57,9
280		80,4	58,6	68,6
250	89,0			
224		87,8	76,5	79,8
180			88,9	88,3
150	98,1			
140		96,0	94,3	92,8
112			97,0	
90		98,6		
63				
56		100,0		
36		100,0		
0	100,0	100,0	100,0	100,0

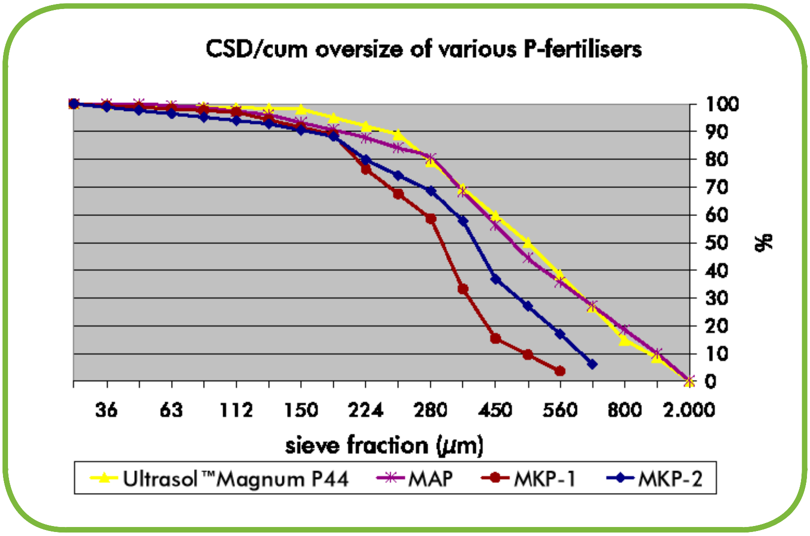


Figure 3. CSD/Cumulative oversize of various P-fertilisers.

1.7.2 Conclusions

The crystal size distribution varies between salts and between producers of the same salt (MKP-1, MKP-2). The available MAP sample may not be of typical commercial size. A coarser product has less caking tendency.

1.8 Results of Sieve Analysis

This paragraph shows the sieve fraction distribution of Ultrasol™ Magnum P44, MAP and MKP. A D50 indicates at which sieve size 50% of the fraction will pass. A D90 indicates at which sieve size 90% of the fraction will pass. For example: a fertiliser with a D90 of 900 µm indicates that it has a coarser crystal distribution than a fertiliser with a D90 of 500 µm.

1.8.1 Sample: Ultrasol™ Magnum P44

Table 3. Sieve analysis of Ultrasol™ Magnum P44.

Sieve size (µm)	g	%	Cumul	Passed
1.000	8,52	8,52	8,52	91,48
800	6,42	6,42	14,94	85,06
500	34,94	34,94	49,88	50,12
250	39,09	39,09	88,97	11,03
150	9,12	9,12	98,09	1,91
0	1,91	1,91	100,00	0,00
Total	100,00	100,00		

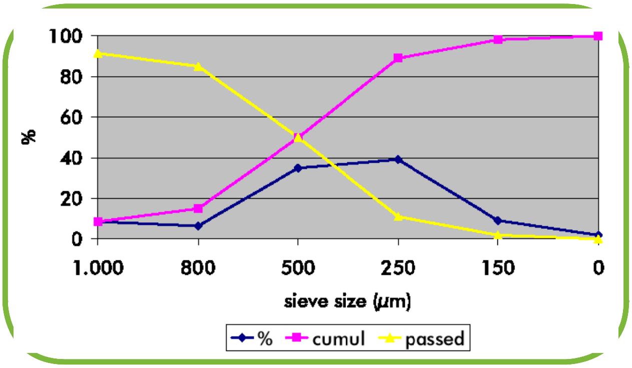


Figure 4. Sieve analysis of Ultrasol™ Magnum P44.

D50	µm	500
D5	µm	184
D90	µm	954
D16	µm	282
D84	µm	791

Table 4. Sieve analysis of Ultrasol™ Magnum P44.

1.8.2 Sample: MKP-1

Table 5. Sieve analysis of MKP-1.

Sieve size (µm)	g	%	Cumul	Passed
560	1,6	3,6	3,6	96,4
450	5,0	11,8	15,4	84,6
355	7,6	17,8	33,2	66,8
280	10,8	25,4	58,6	41,4
224	7,6	17,9	76,5	23,5
180	5,3	12,4	88,9	11,1
140	2,3	5,4	94,3	5,7
112	1,2	2,7	97,0	3,0
0	1,3	3,0	100,0	0,0
Total	42,5	100,0		

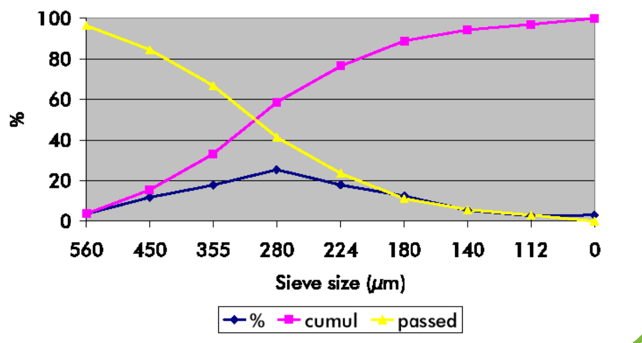


Figure 5. Sieve analysis of MKP-1.

D50	µm	305
D5	µm	133
D90	µm	501
D16	µm	197
D84	µm	447

Table 6. Sieve analysis of MKP -1.

1.8.3 Sample: MAP, Crystalline

Table 7. Sieve analysis of MAP.

Sieve size (µm)	g	%	Cumul	Passed
2.000	0,1	0,2	0,2	99,8
1.000	8,5	9,8	9,9	90,1
500	30,1	34,5	44,4	55,6
280	31,4	36,0	80,4	19,6
224	6,5	7,4	87,8	12,2
140	7,2	8,2	96,0	4,0
90	2,3	2,6	98,6	1,4
56	1,2	1,3	100,0	0,1
36	0,0	0,0	100,0	0,0
0	0,0	0,0	100,0	0,0
Total	87,3	100,0		

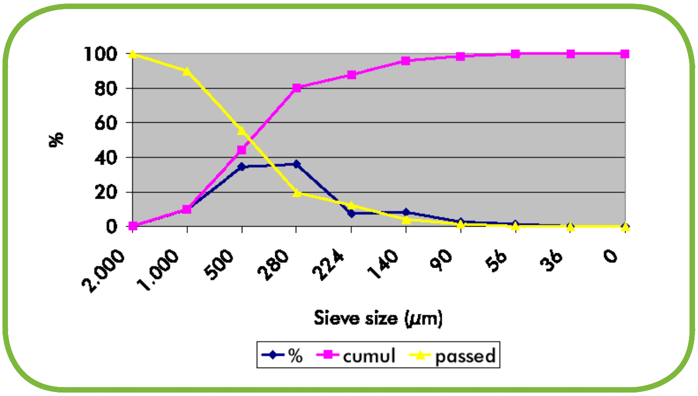


Figure 6. Sieve analysis of MAP.

1.9 pH of Ultrasol™ Magnum P44 Solution

1.9.1 Effect of Ultrasol™ Magnum P44 on the pH of Water with Initial pH 8,2

Table 8. Evolution of the pH of an Ultrasol™ Magnum P44 solution in ion-exchanged water, adjusted to pH 8,2 with sodium hydroxide (NaOH).

Ultrasol™ Magnum P44			
g/1.684 g water	g added/ 100 g water	% in solution	pH
0,000	0,000	0,000	8,20
0,012	0,0007	0,0007	4,44
0,023	0,0013	0,0013	4,10
0,027	0,0016	0,0016	4,02
0,056	0,0033	0,0033	3,69
0,175	0,0104	0,0104	3,21
0,469	0,0279	0,0279	2,83
1,34	0,0799	0,0798	2,45
2,31	0,137	0,137	2,27
5,01	0,298	0,297	2,04
10,1	0,597	0,594	1,85
15,9	0,945	0,936	1,73
21,6	1,28	1,27	1,65
28,2	1,68	1,65	1,59
35,0	2,08	2,04	1,54
52,8	3,14	3,04	1,44

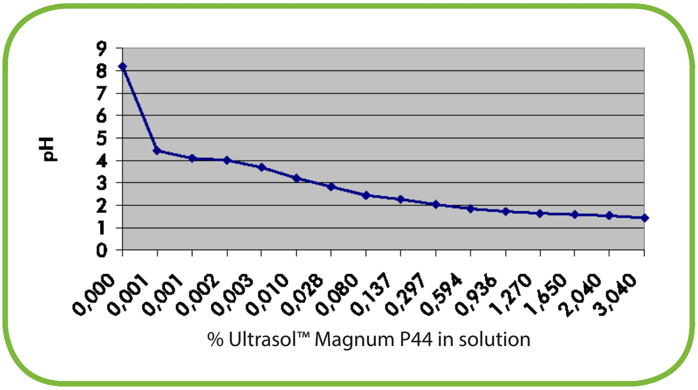


Figure 7. Evolution of the pH of an Ultrasol™ Magnum P44 solution in ion-exchanged water, adjusted to pH 8,2 with sodium hydroxide (NaOH).

1.9.2 Effect of Ultrasol™ Magnum P44 on the pH of Water with Initial pH 7,9 and 6,9

Table 9. Evolution of the pH of an Ultrasol™ Magnum P44 solution in ion-exchanged water with pH 6,9 and water adjusted to pH 7,9 with sodium hydroxide (NaOH).

Ultrasol™ Magnum P44			pH	
g/200 g water	g added/ 100 g water	w - % in solution		
0	0	0,0	7,90	6,90
2	1	1,0	1,72	1,71
4	2	2,0	1,54	1,54
6	3	2,9	1,45	1,44
8	4	3,8	1,38	1,38
10	5	4,8	1,33	1,33
12	6	5,7	1,29	1,29
14	7	6,5	1,25	1,25
16	8	7,4	1,23	1,23
18	9	8,3	1,20	1,20
20	10	9,1	1,18	1,18
22	11	9,9	1,16	1,16
24	12	10,7		1,12

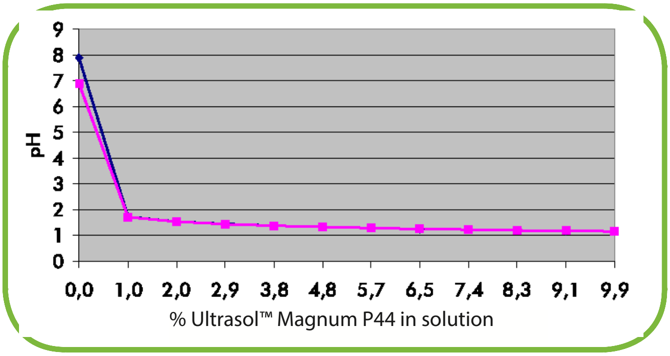


Figure 8. Evolution of the pH of an Ultrasol™ Magnum P44 solution in ion-exchanged water with pH 6,9 and water adjusted to pH 7,9 with sodium hydroxide (NaOH).

1.9.3 Effect of Ultrasol™ Magnum P44 on the pH of Water with initial pH 5,9

Table 10. Evolution of the pH of an Ultrasol™ Magnum P44 solution in ion-exchanged water with pH 5,9.

Ultrasol™ Magnum P44			
g/1.610 g water	g added/ 100 g water	w - % in solution	pH
0,000	0,000	0,000	5,90
0,012	0,001	0,001	4,05
0,056	0,004	0,004	3,60
0,117	0,007	0,007	3,32
0,214	0,013	0,013	3,09
0,291	0,018	0,018	2,98
0,361	0,022	0,022	2,90
0,569	0,035	0,035	2,73
0,590	0,037	0,037	2,72
1,550	0,096	0,096	2,39
3,630	0,230	0,230	2,22
6,130	0,380	0,380	2,03
9,350	0,580	0,580	1,89
12,600	0,780	0,770	1,81
15,800	0,980	0,970	1,74
17,000	1,060	1,050	1,72
49,200	3,060	2,970	1,47

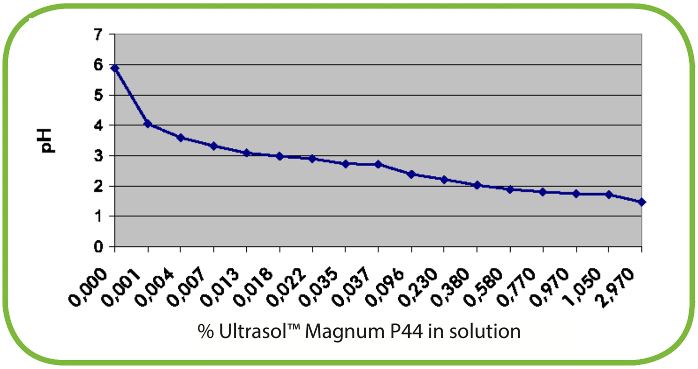


Figure 9. Evolution of the pH of an Ultrasol™ Magnum P44 solution in ion-exchanged water with pH 5,9.

1.9.4 Conclusions

The pH drops from 6-8 to 2 with only small amounts of 0,3-0,5 % Ultrasol™ Magnum P44 in solution.

1.10 Calculation of the Quantity of Phosphoric Acid or Ultrasol™ Magnum P44 Needed to Neutralize Bicarbonate in Irrigation Water

Phosphoric acid neutralizes bicarbonate based on the following formulae:

pH range < 4:

$$HCO_3^- + H_3PO_4 \longrightarrow CO_2 + H_2PO_4^- + H_2O$$

pH range 4 – 8,5:

$$2HCO_3^- + H_3PO_4 \longrightarrow CO_2 + H_2PO_4^{2-} + 2H_2O$$

First example of how to calculate the quantity of phosphoric acid to reduce the bicarbonate content of water from 100 to 30 mg/litre (reduction is 70 mg/l).

Given:

- Molecular weight of H_3PO_4 (100% acid) is 98 gram.
- Molecular weight of HCO_3^- is 61 gram.
- Specific eight of 85 % phosphoric acid is 1,69-1,71 kg per litre.

Calculation 1:

(molecular weight of H_3PO_4 (g) / molecular weight of HCO_3^- (g)) x quantity of HCO_3^- (mg/l) = quantity of H_3PO_4 (mg/l or g/m^3).

Answer: (98 / 61) x 70 = 112,5 g H_3PO_4/m^3.

Calculation 2:

Quantity of H_3PO_4 (g/m^3) / (strength of the acid (%) x specific weight of acid) = quantity of H_3PO_4 (x% strength) (ml).

Answer: 112,5 g H_3PO_4/m^3 / (0,85 x 1,71) = 77,4 ml.

Second example of how to calculate the quantity of Ultrasol™ Magnum P44 to reduce the bicarbonate content of water from 100 to 30 mg/litre (reduction is 70 mg/l).

Given:
• Molecular weight of Ultrasol™ Magnum P44 is 158 gram.
• Theoretically 62 % of Ultrasol™ Magnum P44 is H_3PO_4, in practice 60 %.

Therefore:

Calculation 1:

61 mg bicarbonate/l (which equals 1 mmole bicarbonate/ml) will be neutralized by 158 mg Ultrasol™ Magnum P44 (which equals 1 mmole Ultrasol™ Magnum P44 per ml).

Answer:
70 mg bicarbonate/l will be neutralized by (70/61) *158 mg Ultrasol™ Magnum P44 = 181 mg Ultrasol™ Magnum P44 per litre.

Because Ultrasol™ Magnum P44 is a solid, there is no need for the second calculation.

Calculation 2:

The amount of Ultrasol™ Magnum P44 can also be derived from the phosphoric acid calculation on page 35.

Calculation 1 on page 35 resulted in 112,5 g H_3PO_4/m^3 = 112,5 mg H_3PO_4/l.
Theoretically 62 % of Ultrasol™ Magnum P44 is H_3PO_4.

Answer:
112,5/0,62 = 181 mg Ultrasol™ Magnum P44 per litre.

It is recommended that not all the bicarbonate, present in the water, is removed – normally 50-60 mg/l is required for buffering the water to around pH 6,0-6,2, and to stop it from becoming too acidic.

Table 11. Quantities of H_3PO_4 and Ultrasol™ Magnum P44 needed to decrease the HCO_3^- content of irrigation water to 30 mg/litre.

HCO_3^- content of irrigation water	Amount of HCO_3^- to be neutralized	Quantity of H_3PO_4 (85 %) needed	Quantity of Ultrasol™ Magnum P44 needed
mg/l or g/m³	mg/l or g/m³	mg/l or g/m³	mg/l or g/m³
0-30	0	-	-
40	10	18,9	27
50	20	37,8	54
60	30	56,7	81
70	40	75,6	108
80	50	94,5	135
90	60	113,4	161
100	70	132,4	187
150	120	226,8	321
200	170	321,3	454

Table 12. Quantities of Ultrasol™ Magnum P44 and H_3PO_4 equal in neutralizing bicarbonates.

Ultrasol™ Magnum P44 g/m³	H_3PO_4, 85 %, 1,71 kg/l, g/m³	H_3PO_4, 85 %, 1,71 kg/l, ml/m³
25	17,6	10,3
50	35,3	20,6
75	52,9	31,0
100	70,6	41,3
125	88,2	51,6
150	105,9	61,9
175	123,5	72,2
200	141,2	82,6

Titration is a very useful method for estimating the Ultrasol™ Magnum P44 requirement to neutralize the bicarbonate levels to certain pH levels in water with different concentrations of bicarbonate.

Tables 13, 14 and 15 summarize the P and Ultrasol™ Magnum P44 requirement to neutralize the bicarbonate levels to certain pH levels in water with different concentrations of bicarbonate.

For example: If the water contains 200 g HCO_3^-/m^3 and the final pH should become pH 6, then 67,9 grams of elemental P should be added to the water. This equals 346 grams of Ultrasol™ Magnum P44.

Table 13. Requirement of grams of elemental P from Ultrasol™ Magnum P44 per m^3 of water for neutralisation to pH 6 or 6,5.

		g HCO_3^-/m^3					
Initial pH	Final pH	50	100	150	200	250	300
7,0	6,5	6,6	13,3				
7,0	6,0	15,4	30,8				
7,5	6,5		17,5	26,2			
7,5	6,0		33,2	49,0			
8,0	6,5			28,3	37,8		
8,0	6,0			50,9	67,9		
8,5	6,5				39,1	48,9	58,7
8,5	6,0				68,7	85,9	103,0

Table 14. Requirement of grams of Ultrasol™ Magnum P44/m³ water for neutralisation to pH 6 or 6,5.

		g HCO_3^-/m^3					
Initial pH	Final pH	50	100	150	200	250	300
7,0	6,5	34	68				
7,0	6,0	78	157				
7,5	6,5		89	134			
7,5	6,0		169	254			
8,0	6,5			144	193		
8,0	6,0			259	346		
8,5	6,5				199	249	299
8,5	6,0				350	438	525

Table 15. Range of applied g Ultrasol™ Magnum P44/m³ water for final pH 6 - 6,5

		g HCO_3^-/m^3			
Initial pH	Final pH	50 - 100	100 - 150	150 - 200	200 - 300
7,0	6 - 6,5	30 - 160			
7,5	6 - 6,5		90 - 250		
8,0	6 - 6,5			140 - 350	
8,5	6 - 6,5				200 - 500

Figure 10 indicates the amount of Ultrasol™ Magnum P44 needed to partially or fully neutralize the bicarbonate in the water at different levels of bicarbonate.

Suppose the water contains 300 ppm bicarbonate (HCO_3^-). The addition of 260 ppm Ultrasol™ Magnum P44 will reduce the bicarbonate level from 300 ppm to 200 ppm bicarbonate, which means that 100 ppm of bicarbonate is neutralized. The addition of 780 ppm Ultrasol™ Magnum P44 will reduce 300 ppm of bicarbonate, which means that all the bicarbonate is neutralized.

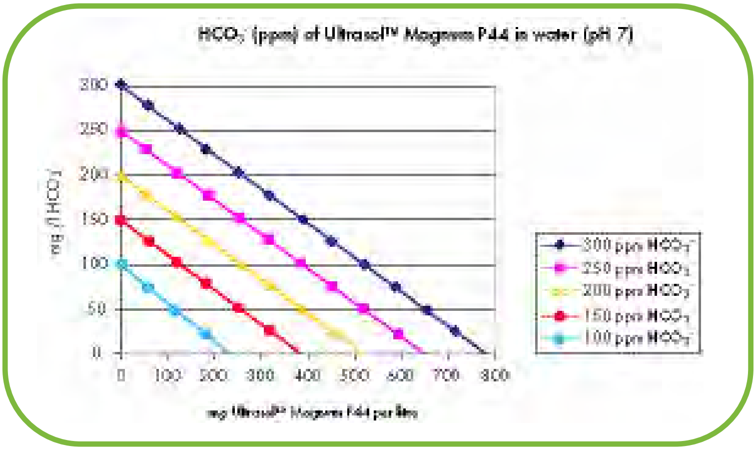


Figure 10. The amount of Ultrasol™ Magnum P44 needed to partially or fully neutralize the bicarbonate in the water at different levels of bicarbonate.

Figure 11 indicates the amount of Ultrasol™ Magnum P44 needed to reduce the pH to a certain level at different levels of bicarbonate in the water. If 500 mg Ultrasol™ Magnum P44 per litre was added to water with 250 ppm bicarbonate, then the pH would drop from pH 7 to pH 5,75.

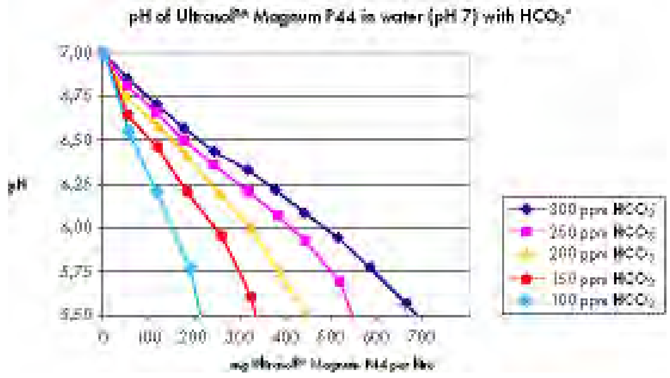


Figure 11. The amount of Ultrasol™ Magnum P44 needed to reduce the pH to a certain level at different levels of bicarbonate in the water.

Figure 12 is a mirror view of Figure 11. It indicates the amount of Ultrasol™ Magnum P44 needed to reach a certain pH level at different levels of bicarbonate in the water. If a pH of 6,0 was desired in water with 100 ppm bicarbonate, then about 160 mg Ultrasol™ Magnum P44 per litre has to be added to the water.

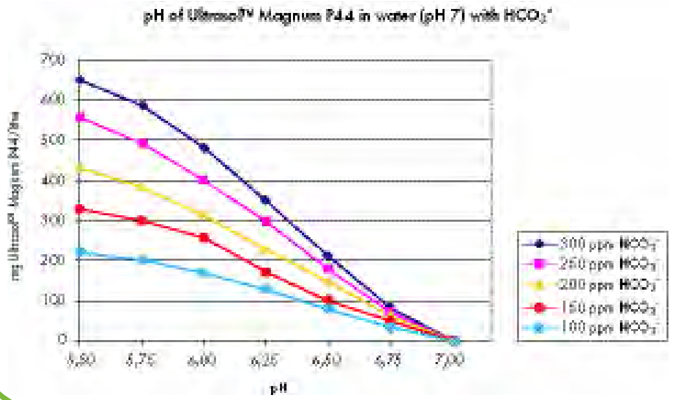


Figure 12. The amount of Ultrasol™ Magnum P44 needed to reduce the pH to a certain level at different levels of bicarbonate in the water.

Table 16 shows how much bicarbonate will be neutralized after adding a specific amount of Ultrasol™ Magnum P44 to the water.

Table 16. The amount of bicarbonate that will be neutralized after adding a specific amount of Ultrasol™ Magnum P44 to the water.

Ultrasol™ Magnum P 44		Bicarbonate
mg/l or ppm	meq/l or mmole/l	mg/l or ppm
50	0,315	19,3
100	0,63	38,6
150	0,95	58
200	1,26	77
250	1,58	97
300	1,89	116
350	2,21	135
400	2,52	154
450	2,84	174
500	3,15	193
550	3,47	212
600	3,78	232
700	4,41	270
800	5,04	309
900	5,67	347
1.000	6,30	386

Table 17 shows how much Ultrasol™ Magnum P44 is needed to neutralize a specific amount of bicarbonate.

Table 17. The amount of Ultrasol™ Magnum P44 that is needed to neutralize a specific amou t of bicarbonate.

Bicarbonate	Ultrasol™ Magnum P 44	
mg/l or ppm	meq/l or mmole/l	mg/l or ppm
30	0,49	78
50	0,82	130
60	0,98	155
90	1,48	233
100	1,64	259
120	1,97	311
150	2,46	389
200	3,28	518
250	4,10	648
300	4,92	777
350	5,74	907
400	6,56	1.036
450	7,38	1.166
500	8,20	1.295

Ultrasol™ Magnum P44 is a very effici t acidifie . A dose of 0,1-1 gram per litre or 100-1.000 ppm will be suffici t to neutralize the bicarbonate levels from 39 to 390 ppm. These are the levels, which are present in most of the irrigation waters (Table 18).

Table 18. The amount of bicarbonate that will be neutralized after adding a specific amount of Ultrasol™ Magnum P44.

Concentration of the Ultrasol™ Magnum P44 Solution			Delta HCO_3^-	
%	g UP/l	ppm (mg/l)	ppm (mg/l)	mmole/l
10,0	100	100.000	39.000	640,0
1,0	10	10.000	3.900	64,0
0,1	1,0	1.000	390	6,4
0,01	0,1	100	39	0,64
0,001	0,01	10	3,9	0,064
0,0001	0,001	1	0,39	0,0064

1.11 Comparison of Electrical Conductivity of Various Fertiliser Solutions

In Table 19 the EC value of various fertilisers is compared.

Table 19. The electrical conductivity of various fertiliser solutions.

Solution	Ultrasol™ MAP	Ultrasol™ MKP	Ultrasol™ Magnum P44	MOP	AS	Ultrasol™ SOP	Ultrasol™ K
	$NH_4H_2PO_4$ mS/cm	KH_2PO_4 mS/cm	$(NH_2)_2CO.H_3PO_4$ mS/cm	KCl mS/cm	$(NH_4)_2SO_4$ mS/cm	K_2SO_4 mS/cm	KNO_3 mS/cm
1g/l	0,86	0,68	1,22	1,79	1,90	1,54	1,35

1.12 Water Hardness

1.12.1 Composition/Information on Ingredients

There are basically two types of water hardness: temporary water hardness and permanent water hardness. No relation exists between temporary water hardness and permanent water hardness, as they are caused by different ions.

Temporary hardness or alkaline hardness is caused by dissolved (Ca and Mg) bicarbonate, carbonate and carbon dioxide. Temporary hardness is sometimes referred to as carbonate hardness (KH) or acid binding capacity (ABC), and is easily removed by boiling. Boiling takes out bicarbonates of calcium and magnesium, which are soluble in water, by precipitation. It is this phenomenon which in hard water areas creates a white scale in the kettle.

High levels of bicarbonate raise the pH of the growing medium e.g. in peat bags and particularly small plugs, which are used extensively for raising seeds. The pH rises and this in turn causes trace elements such as iron and manganese to be unavailable. In addition, deposits around drippers can cause uneven watering and eventually blockages, reducing both water and fertiliser applications.

Ultrasol™ Magnum P44 will dissolve bicarbonate in water and this helps to keep drip systems clean. About 90 - 95% of all bicarbonate is reduced to leave about 30 - 60 ppm or 0,5 - 1 mmole or meq bicarbonate per litre in solution for buffering the water to around pH 6,0 - 6,2, and to stop it from becoming too acid.

The classific tion of temporary water hardness may vary from country to country. An example is given in Table 20.

Table 20. Classific tion of temporary water hardness.

Bicarbonate level		Classification
ppm or mg/l	mmole/l or meq/l	
0 - 125	0 - 2,0	Soft
125 - 200	2,0 - 3,3	Hard
200 - 300	3,3 - 4,9	Very hard
300 - 400	4,9 - 6,6	Extremely hard water

Figure 13 shows the positive effect of a water-soluble NPK containing Ultrasol™ Magnum P44 (left side), compared to the same formula without Ultrasol™ Magnum P44 (right side) in hard water after one month. When a water-soluble NPK containing Ultrasol™ Magnum P44 is used, no precipitates are formed. Such precipitates will block nozzles and drip lines in irrigation systems.

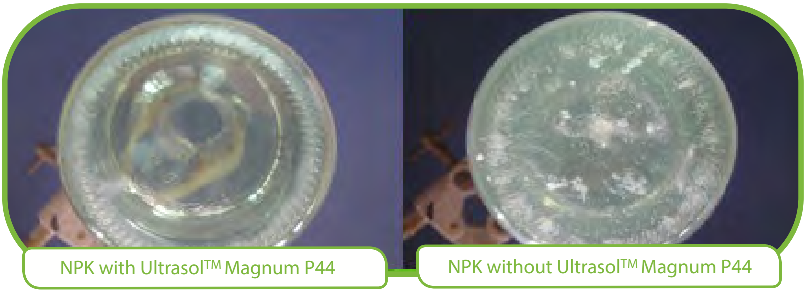


Figure 13. The effect of a wsNPK with Ultrasol™ Magnum P44 as compared to a wsNPK without Ultrasol™ Magnum P44 on the formation of precipitates.

The second type of hardness is known as "permanent hardness". This consists mainly of sulphates and chlorides of calcium, magnesium, iron and other divalent metal ions. These elements cannot be removed by using acid fertilisers or by boiling the water.

Permanent water hardness is measured in mg per litre (ppm) of calcium carbonate equivalents, accounting for calcium, magnesium and other metals in solution.

Older scales are expressed in degrees of hardness (Tables 21 to 24).

Table 21. Summary of some old scales to express permanent water hardness.

Scale	Expression	ppm $CaCO_3$	ppm CaO
French	1 °FH	10,0	5,6
German	1 °DH	17,8	10,0
English	1 °Clark	14,3	8,0
USA	1 Grain per gallon	17,1	9,6
	°Hardness	17,1	9,6

Source:http://www.thatfishsho .com/chemistry/hardness.htm

Table 22. French scale to express permanent water hardness.

°FH	Hardness	ppm or g $CaCO_3/m^3$
0 - 14	Soft	0 - 140
14 - 26	Moderately hard	140 - 260
26 - 35	Hard	260 - 350
> 35	Very hard	> 350

Table 23. German scale to express permanent water hardness.

°DH	Hardness	ppm or g $CaCO_3/m^3$
0 - 4	Very soft	0 - 71
4 - 8	Soft	71 - 142
8 - 12	Medium	142 - 214
12 - 18	Moderately hard	214 - 308
18 - 30	Hard	308 - 513
> 30	Very hard	> 513

Table 24. USA scale to express permanent water hardness.

Grains/gallon	Hardness	$CaCO_3$ in ppm or g/m³
0 - 1	Soft	0 - 17,1
1 - 3,5	Slightly hard	17,1 - 60
3,5 - 7	Moderately hard	60 - 120
7 - 10,5	Hard	120 - 180
> 10,5	Very hard	> 180

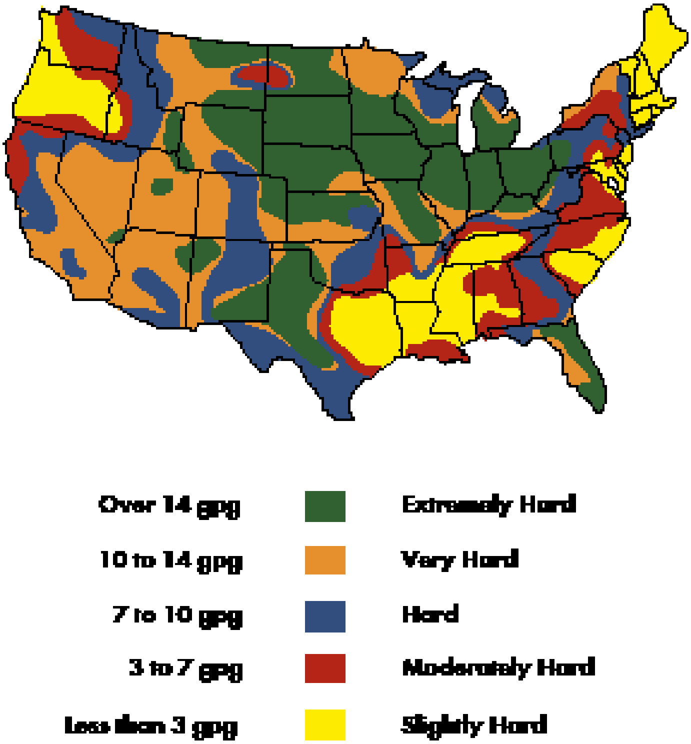


Figure 14. USA map and scale to express permanent water hardness.

Source: http://www.yourwaterneeds.com/AR_US_Hardness_Map.asp

1.12.2 Neutralizing Effect of Ultrasol™ Magnum P44

A solution of Ultrasol™ Magnum P44 or Ultrasol™ Magnum Flex formulae containing this product will remove the following levels of bicarbonate from the irrigation water:

Table 25. The neutralizing effect of Ultrasol™ Magnum P44 and Ultrasol™ Magnum Flex formulae on bicarbonate levels in the irrigation water.

Neutralizing Effect of Ultrasol™ Magnum P44 and Ultrasol™ Magnum Flex Formulae						
Formula	Solution strength g/l	EC solution mS/cm	Bicarbonate removed with 1 g formula/l mg/l	Nutrients		
				N mg/l	P_2O_5 mg/l	K_2O mg/l
Ultrasol™ Magnum P44	0,1	0,15	39	18	44	0
Ultrasol™ Magnum P44	0,2	0,30	76	35	88	0
Ultrasol™ Magnum P44	1,0	1,22	390	175	440	0
Ultrasol™ Magnum Flex Starter	1,0	1,26	261	160	300	160
Ultrasol™ Magnum Flex Flowering and Fruit Set	1,0	1,31	133	150	150	300
Ultrasol™ Magnum Flex Production	1,0	1,33	62	140	70	390
Ultrasol™ Magnum Flex Multipurpose	1,0	1,29	195	160	220	230

For more information about the Ultrasol™ Magnum Flex Concept, see Appendix 1.

1.13 Global Distribution of Soil pH

Due to its acidifying nature, Ultrasol™ Magnum P44 is particularly suitable for calcareous and alkaline soil conditions. These conditions are met in the green coloured areas, which have an alkaline pH of 7,3 < pH < 8,5.

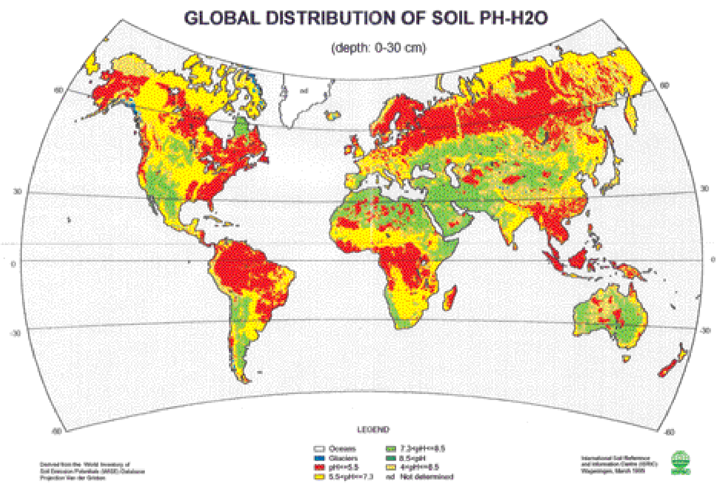


Figure 15. Global distribution of soil pH.
Source: Prepared by the ISRIC Wageningen, on behalf of Akzo Nobel Micronutrients.

1.14 Comparison Table of Various Fertilisers

Table 26 compares various types of P--fertilisers.

Table 26. Comparison table of various fertilisers.

Product	Nutrients content	pH	Physical Form	Solubility (20 °C) g/l	Electrical Conductivity 0,1% solution (20 °C) mS/cm	Compatibility with other straights	Major advantages	Major disadvantages
UP	N 18% P_2O_5 44%	2,0	Powder	960	1,22	Good	Acid in powder form, high solubility.	Not suitable for inert substrates and hydroponics.
H_3PO_4	P_2O_5 61%	1,0	Liquid	5.480	2,15	Good	Very acidic, concentrated.	Hazardous to handle.
MAP	N 12% P_2O_5 61%	4,7	Powder	380	0,77	Good	High in P, slightly acidic.	Not ideal for alkaline conditions.
MKP	P_2O_5 52% K_2O 34%	4,5	Powder	230	0,66	Good	Very concentrated, low EC.	P:K ratio not optimal.
DAP	N 21% P_2O_5 53%	8,0	Powder	690	1,46	Difficult to use in alkaline irrigation water	Concentrated in P.	Not suitable for alkaline soils and waters, not suitable as raw material in NPKs with Mg or S.

1.15 The Use of Ultrasol™ Magnum P44 as a Fertiliser and in Fertiliser Mixtures

1.15.1 Ultrasol™ Magnum P44 Can Be Mixed with Other Fertilisers

Urea phosphate can be mixed with other fertilisers and can be used in fertiliser mixes to create acid water-soluble fertilisers.

Table 27. The nutrient contribution in N and P per amount of Ultrasol™ Magnum P44 applied (kg/ha).

Ultrasol™ Magnum P44	Kg/ha		
	N	P	P_2O_5
100	17,5	19,2	44,0
200	35,0	38,4	88,0
300	52,5	57,6	132,0
400	70,0	76,8	176,0
500	87,5	96,0	220,0
600	105,0	115,2	264,0
700	122,5	134,4	308,0
800	140,0	153,6	352,0
900	157,5	172,8	396,0
1.000	175,0	192,0	440,0

Table 28. The nutrient contribution in N and K per amount of Ultrasol^{TM} K applied (kg/ha).

Ultrasol™ K	Kg/ha		
	N	K	K_2O
100	13,5	37,8	45,5
200	27,0	75,6	91,0
300	40,5	113,4	136,5
400	54,0	151,2	182,0
500	67,5	189,0	227,5
600	81,0	226,8	273,0
700	94,5	264,6	318,5
800	108,0	302,4	364,0
900	121,5	340,2	409,5
1.000	135,0	378,0	455,0

For example, if the desired rates for plant nutrition were 107 kg N/ha, 132 kg P_2O_5/ha (58 kg P/ha) and 182 kg K_2O/ha (151 kg K/ha), then 300 kg Ultrasol^{TM} Magnum P44 and 400 kg Ultrasol™ K should be applied (Tables 27 and 28).

Ultrasol^{TM} Magnum P44 can be perfectly mixed with Ultrasol^{TM} Calcium in various concentrations, whereas any other commonly used water-soluble phosphate fertiliser (MAP, MKP or water-soluble NPKs based on MAP or MKP) would form an insoluble calcium phosphate precipitate.

The strong acidifying effect of Ultrasol^{TM} Magnum P44 prevents the undesired formation of precipitates in the irrigation system and consequently prevents clogging of the drippers.

Figure 16 and Table 29 indicate how various mixes can be made without facing precipitations. For example: in a solution with 200 g Ultrasol^{TM} Calcium per kg solution, a maximum of 250 g of Ultrasol^{TM} Magnum P44 per kg solution can be dissolved. Or otherwise said: under practical conditions, and providing standard nutrition recommendations have been respected, no problems arising from such mixes should be expected.

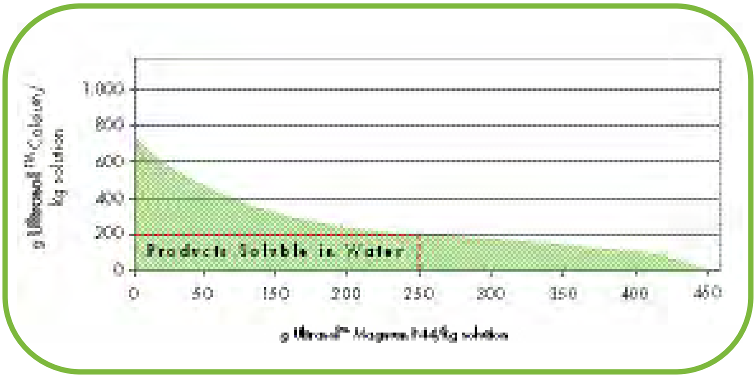


Figure 16. Solubility of Ultrasol™ Magnum P44 and Ultrasol™ Calcium (19% Ca) in concentrated solutions.

Table 29. Solubility of Ultrasol™ Magnum P44 and Ultrasol™ Calcium (19% Ca) in concentrated solutions.

Measured Maximum Solubility in Water			
Ultrasol™ Magnum P44 in g	Ultrasol™ Calcium in g	g Water	Final Weight in g
0	720	280	1,000
50	550	400	1,000
100	400	500	1,000
150	300	550	1,000
200	250	550	1,000
250	200	550	1,000
300	150	550	1,000
350	100	550	1,000
450	0	550	1,000

1.15.2 Application in the Open Field

1st example of fertigation

30 % stock solution	200 kg urea phosphate / 660 litres water.
Mixing ratio 1:100	→ the solution concentration 0,3% (88 kg P_2O_5/ha, 39 kg P/ha and 35 kg N/ha, the amount of water per hectare being 66.000 litres, which is equivalent to 6,6 mm of rainfall).

2nd example of fertigation (see Table 32)

30 % stock solution	300 kg urea phosphate / 1.000 litres water.
Mixing ratio 1:100	→ the solution concentration 0,3% (132 kg P_2O_5/ha, 57,6 kg P/ha and 52,5 kg N/ha, the amount of water per hectare being 100.000 litres (100 m^3), which is equivalent to 10 mm of rainfall).

Table 30. The calculation of the amount of irrigation water needed to apply a required amount of nutrients via Ultrasol™ Magnum P44 in a fertigation system to the fiel .

Stock solution 300 kg Ultrasol™ Magnum P44 /m³	Mixing ratio	Solution concentration %	Final solution kg Ultrasol™ Magnum P44 /m³	Amount of nutrients per m³ water			Required amount of nutrients			Water per hectare needed to apply required amount of nutrients	
				P_2O_5 kg/m³	P kg/m³	N kg/m³	P_2O_5 kg/ha	P kg/ha	N kg/ha	m³	mm
30%	1:50	0,60	6,0	2,64	1,15	1,05	132	57,6	52,5	50	5
30%	1:100	0,30	3,0	1,32	0,58	0,53	132	57,6	52,5	100	10
30%	1:200	0,15	1,5	0,66	0,29	0,26	132	57,6	52,5	200	20

1.15.3 Application in Greenhouses

Ultrasol™ Magnum P44 can be used in the greenhouse for soil grown crops. It is not recommended for use in hydroponics.

a) as fertiliser raw material up to 250 kg per tonne. Even more can be applied but then the amount of phosphorous will rise unnecessarily high for the plants.

b) for neutralization of bicarbonate.

1.15.4 Foliar Applications

Ultrasol™ Magnum P44 can be used in foliar application too for its nutritional contribution or as an acidifier of the spray tank mix in order to increase the stability of pesticides. It is applied in dose rates from 0,1-3% depending on crop, growth stage, and final pH of the tank mix solution. For more information about foliar application see Chapter 2.1.2.

1.15.5 Acid NPK Production

Ultrasol™ Magnum P44 can be used as a raw material for NPK production. For fertigation purposes a dose of at least 180 kg Ultrasol™ Magnum P44/MT NPK is desired to have suffici t acidifying power in the final nutrient solution, especially under hard water conditions, in order to bring down the pH < 6,5. Certain limitations in producing acid NPKs may exist with respect to patents (See Chapter 5).

2 Trials

2.1 Application trials

2.1.1 Fertigation Trials

2.1.1.1 Citrus-Spain

General

Research at the Universidad Politécnica de Valencia, Spain (2002-03) targeted agronomic and soil related differences of the two common P-fertilisers Ultrasol™ Magnum P44 and MAP applied to citrus orchards under practical field onditions in a sandy loam soil.

The trial design included 3 treatments (Ultrasol™ Magnum P44, Ultrasol™ Magnum P44 -25%, MAP) and 4 replications per treatment in a randomized block design.

Results

Analysis of foliar nutrients, fruit quality and yield, and analysis of various soil and soil solution parameters (Table 30) revealed the following key results:

Ultrasol™ Magnum P44 versus MAP treatments resulted in:

- enhanced penetration of P within the wet bulb.
- increased electrical conductivity of the soil solution due to an increased release of soil nutrients (NO_3^-, K^+, Ca^{2+}) (Figure 17).
- reduced pH in the soil solution of the wet bulb down to 50 cm depth (Figure 18).
- increased availability of NO_3-N.
- increased availability of soluble K (about 50% increase in concentration) which resulted in a significa t higher foliar K level.
- Ultrasol™ Magnum P44 -25% and MAP treatments gave similar amounts of P in the crop.
- earliness in yield, i.e. higher yield during the first ha vest.
- higher crop quality, expressed in fruit sugar, acid and Brix levels (Figure 19).

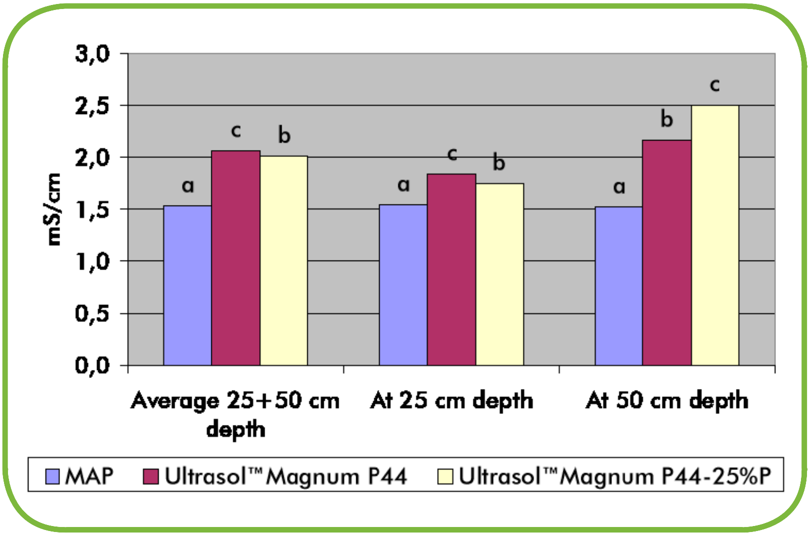


Figure 17. The EC value of the soil solution (mS/cm) measured at two soil depths with three different P-fertiliser treatments (P=0,01).

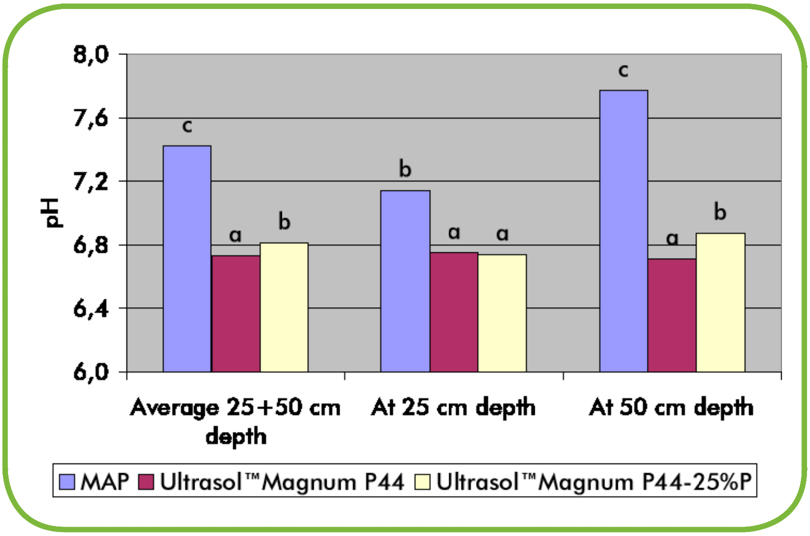


Figure 18. The pH value of the soil solution measured at two soil depths with three different P-fertiliser treatments (P=0,01).

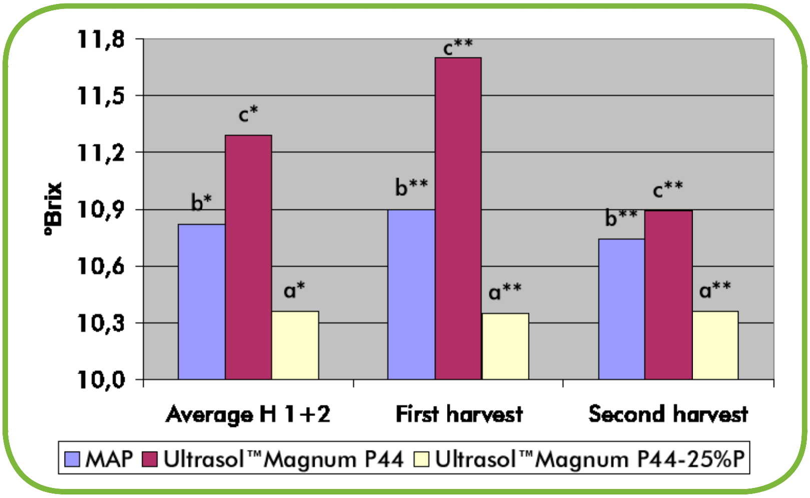


Figure 19. The degrees Brix content of fruits on average and during the first and the second harvest with three different P-fertiliser treatments.
** = significa t at P=0,05   ** = significa t at P = 0,01.*

Table 31. Composition of the soil solution as affected by 3 P-fertiliser treatments.

Parameter	Value	Irrigation water	Treatments: Ultrasol™ MAP		Ultrasol™ Magnum P44		Ultrasol™ Magnum P44 -25%	
EC	mS/cm	1,49	1,53	a**	2,07	c**	2,01	b**
pH		7,1	7,4	c**	6,7	a**	6,8	b**
Chloride	mg/l	256	187	a*	246	b*	241	b*
Sulphate	mg/l	326	280	a**	412	c**	339	b**
Nitrate	mg/l	40	144	a*	242	b*	239	b*
Bicarbonate	mg/l	267	193	NS	210	NS	201	NS
Phosphate	mg/l	0	19	NS	22	NS	21	NS
Potassium	mg/l	3	114	NS	173	NS	154	NS
Calcium	mg/l	104	91	a**	117	b**	125	b**
Sodium	mg/l	58	45	a**	45	b**	56	b**
Magnesium	mg/l	62	47	NS	53	NS	50	NS

*NS = non significa t   * = significa t at P=0,05   ** = significa t at P = 0,01.*

Conclusions

The use of Ultrasol™ Magnum P44 in fertigation as compared to MAP led to a significa t increase of nutrient release in the soil solution, nutrient uptake, earliness in yield and crop quality.

Detailed information about the trial

Treatments

The trial design included 3 treatments (Ultrasol™ Magnum P44, Ultrasol™ Magnum P44 -25%, MAP).

The only variable was the P-source and its dose. All other nutrient levels were kept the same. The fertiliser dosage rates were based on foliar analysis. In total, 185 kg N/ha, 40 kg P_2O_5/ha and 115 kg K_2O/ha were applied.

The citrus variety was Oronules (Clementina - Citrus clementina).

Plot size and replications

Per replication six suction pumps were placed, of which one at a depth of 25 cm and another one at a depth of 50 cm, with a distance of 0,25 and 0,5 m from the emitter. In total, 72 measurements were taken (3 suction pumps * 2 depth levels * 4 replications * 3 treatments). During the cropping cycle from April to October, 7 times 72 = 504 samples were taken.

Irrigation

Drip irrigation was applied. Four emitters were placed per tree with a discharge rate of 4 litres per hour.

2.1.1.2 Cucumber - Jordan

General

It has been argued that Ultrasol™ Magnum P44, due to its acidity and purity, works much more effici tly than other P-sources such as MAP – particularly in calcareous soils. In various trials, e.g. in Cyprus this question has been focused, quite often with the result that a reduction of P-application rate by about 25% compared to MAP application did not negatively affect crop performance and yield. Although such a statement may not be generalized, and more trials and investigations into this question would be required, it might be true for many situations that slight P-rate reductions of Ultrasol™ Magnum P44 will not have negative impact on crop yields. In part the reasons for this might be the very high P-status of many soils under vegetable production and the assumption that acidic Ultrasol™ Magnum P44 is more able to make use of the high extractable soil phosphorous pool than any other fertiliser P-source. The demonstration trial on cucumbers here below (Jordan, 2003) is based on a sound data record and it exemplifies and proves the superior performance of Ultrasol™ Magnum P44 versus MAP, even if P-rates are reduced by 28%.

Results

Two fertigation treatments which mainly differed in P-source (Ultrasol™ Magnum P44 vs. MAP) and P-rate have been compared in a protected cucumber trial. Key figu es of the trial are as follows (Table 32):

Table 32. The effect of two fertigation treatments which mainly differed in P-source (Ultrasol™ Magnum P44 *versus MAP) and P-rate on the yield of cucumber under protected cultivation.*

Cardinal Figures, Demonstration Trial on Cucumbers, Jordan 2003

Treatments	Nutrient rates (kg/ha)			Yield
	N	P_2O_5	K_2O	(tonne/ha)
Ultrasol™ Magnum P44	134	110	147	57,2
MAP	144	152	147	46,5
Difference (%)	-7%	-28%	0	+23%

Conclusions

With Ultrasol™ Magnum P44 as compared to MAP the cucumber yield increased with 23% or 10,7 tonne per ha.

2.1.1.3 Eggplant - Cyprus

General

The objective of this trial was to investigate the performance of various P-fertiliser sources on fertigated eggplant. The soil of the trial field was very calcareous and highly alkaline, its pH was 8,2. The applied irrigation water was alkaline.

The applied P-sources were monoammonium phosphate (MAP), diammonium phosphate (DAP) and Ultrasol™ Magnum P44.

The fertigation programme for all the treatments was otherwise similar; the only difference was the P-source. In order to test the efficiencie of the P-sources, two P-dosages were included in the trial, i.e. the local recommendation, and 25% less than that. Eggplant was selected as test crop bearing in mind that efficie y of P-fertiliser is particularly important for crops with weak root systems. Fertiliser applications of micro-nutrients were not made at all.

Results

The total yield of various treatments was significa tly higher from the Ultrasol™ Magnum P44 treatment (Figure 20), which resulted in the highest farmer's income (Figure 21). The number of fruits was also increased when using Ultrasol™ Magnum P44. The average weight of eggplant fruits was however similar in all treatments. The fertiliser cost (US$/ tonne yield) was highest for DAP in comparison with Ultrasol™ Magnum P44 and MAP for both P treatments (Figure 22).

The Ultrasol™ Magnum P44 treatments gave better fruit setting compared to the other P-sources, irrespective of the P-dosage. The best fruit setting and consequently the highest overall yield was achieved by Ultrasol™ Magnum P44 treatment with lower P-level.

The yield increase obtained by the Ultrasol™ Magnum P44 treatment was 6% higher compared to MAP and 11 % higher compared to DAP at the standard recommended P-dose. At the lower P-level (-25% P) the yield increase obtained by the Ultrasol™ Magnum P44 treatment was 8 % higher compared to MAP and 21 % higher compared to DAP compared to the local practice. This result is most evidently due to the acidific tion effect of Ultrasol™ Magnum P44, which in turn increases P-uptake by the plant and furthermore N-uptake due to less losses of urea-N in alkaline conditions. Additionally, it is very likely that acidific tion of alkaline soils also increased plant availability of soil micro-nutrients.

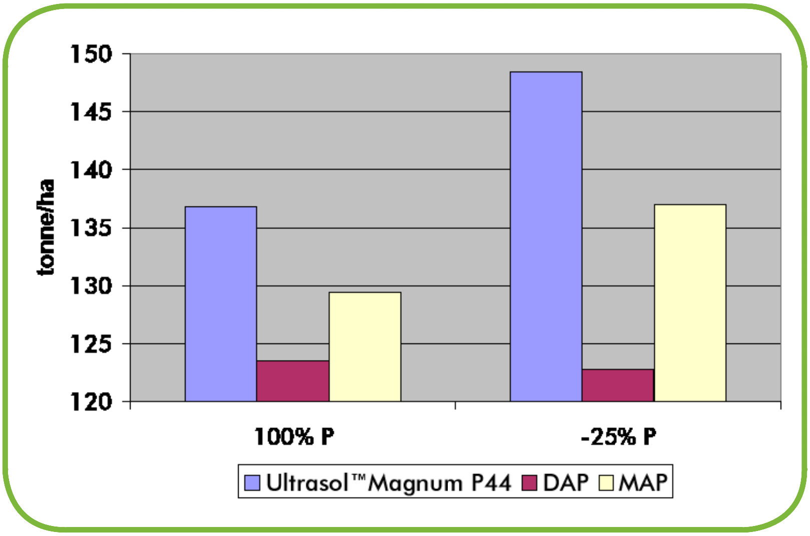


Figure 20. The effect of different P-sources and levels on eggplant yield.

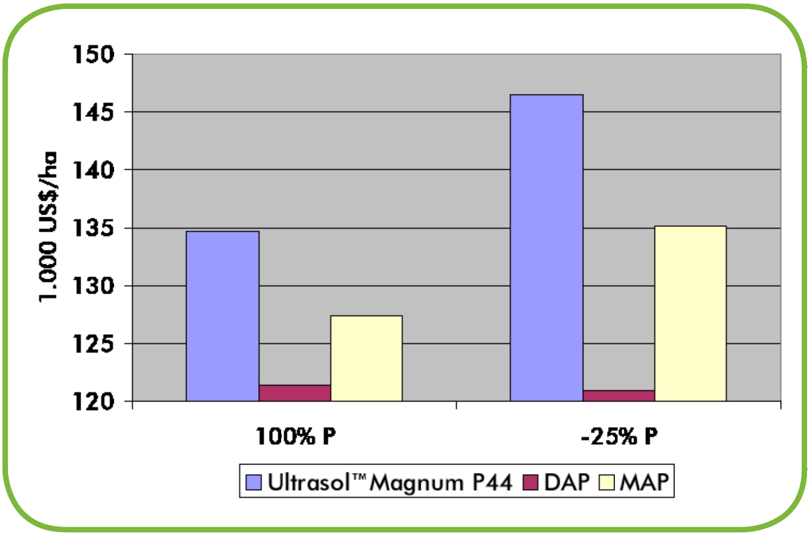


Figure 21. The effect of different P-sources and levels on farmer's income.

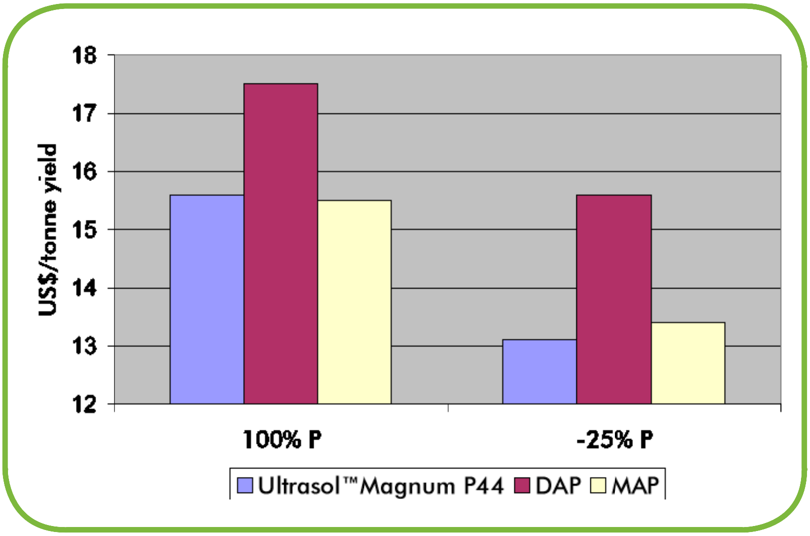


Figure 22. The effect of P-sources on fertiliser cost per tonne of eggplant produced.

Conclusions

The use of Ultrasol™ Magnum P44 in eggplant resulted in up to 21% more yield and up to 21% more net profi .

Detailed Information About the Trial

Treatments

The following figu es stand for concentrations of nutrients in feeding solution, N - P_2O_5 - K_2O (ppm = mg/l):

1. Ultrasol™ Magnum P44 -1	120 - 115 - 240
2. DAP-1	120 - 115 - 240
3. MAP-1	120 - 115 - 240*
4. Ultrasol™ Magnum P44 -2	120 - 80 - 240
5. DAP-2	120 - 80 - 240
6. MAP-2	120 - 80 - 240

* present local recommendation for eggplant.

Other fertiliser sources were KNO_3 and NH_4NO_3 so that the dosages of N and K were equal in every treatment.

Plot size and replicates

Size of plot was 3,6 x 10 m, and every treatment was replicated four times.

Planting and harvesting dates

Eggplant variety used was "Bonica", seedlings were transplanted on 18th April and fina harvesting was made on 17th October, 1996.

Irrigation

The amount of water was based on Epan evaporation starting with 0,3 and gradually increasing at full growth to full Epan evaporation. In total 695 m^3 of water was applied to the trial area which corresponds to 8.043 m^3 per ha. The fertiliser injection was started from the third irrigation and continued until the first eek of October.

2.1.1.4 Green Melon 'Piel de Sapo' - Spain

General

A trial in green melon ("Piel de sapo" type of melon) was carried out at CIFACITA Campo de Cartagena, Murcia in Spain. The target of this trial was to determine the agronomic and economic efficie y of Ultrasol™ Magnum P44.

The soil had a clay-loam texture with a very alkaline pH. The applied irrigation water was alkaline.

Treatments

The plant density was 2 m between rows, 1,6 m within the row, which means 0,3125 plants per m^2. The number of replications was 4.

The treatments consisted of two P_2O_5 levels:
100% P_2O_5 = 100 kg P_2O_5 /ha
50% P_2O_5 = 50 kg P_2O_5 /ha.

The applied products were Ultrasol™ Magnum P44, MAP and a standard application of base dressing 150 kg NPK 15-15-15 per ha plus phosphoric acid.

Results

Table 33 shows the results of the treatments. The use of Ultrasol™ Magnum P44 resulted in 7-19% more yield and 10-23% more net profi . Even the use of only 50% of the recommended amount of P via Ultrasol™ Magnum P44 resulted in higher yields (+ 1,8 tonne/ha) and income (+ 727 €/ha) as compared to the standard treatment.

Table 33. The effect of different fertiliser treatments on the melon yield, production value and extra net income.

	Treatments				
	1	2	3	4	5
	Ultrasol™ Magnum P44 100%	MAP 100%	Ultrasol™ Magnum P44 90%	MAP 90%	Standard based. + P.acid
Fertilisation cost (€/ha)	805	783	769	759	921
Yield (kg/ha)	31,500	28,900	28,200	28,000	26,400
Production value (€/ha)	10,080	9,248	9,024	8,960	8,448
Production value minus fertilisation cost (€/ha)	9,275	8,465	8,255	8,201	7,527

Differences	Yield		Extra net income	
	kg/ha	%	(€/ha)	%
1-5 [Ultrasol™ Magnum P44 100% minus Standard]	5,100	19,3	1,748	23,2
1-2 [Ultrasol™ Magnum P44 100% minus MAP 100%]	2,600	9,0	810	9,6
3-5 [Ultrasol™ Magnum P44 90% minus Standard]	1,800	6,8	727	9,7

Conclusions

The use of Ultrasol™ Magnum P44 in fertigation as compared to other P-fertilisers resulted in 7-19% more yield and 10 - 23% more net profi .

References

http://www.fertiberia.com/informacion_fertilizacion/articulos/abonado_cultivos/fosforo_melon.html

Cifacita. Extracto de Artículo de la revista "Horticultura" nº 178 de julio de 2004. Pág 12 – 19.

2.1.1.5 Potato - Cyprus

General

The objective of this trial was to compare the performance of MAP and Ultrasol™ Magnum P44 on fertigated winter potato in a demonstrative trial on a farmer's fiel . The soil of the trial field was red soil and it was slightly alkaline, pH was 7,4. The applied irrigation water was slightly alkaline.

The fertigation programme and the dosages of nutrients in kg per ha for both treatments were virtually similar; the only difference was the applied P-source. The potato variety was Spunta and the size of each plot was 0,5 ha. Fertiliser applications of micro-nutrients were not made at all.

The analyses made were: total yield, specific gravity, dry matter content and NO_3-N content of tubers.

Results

The results indicate that with Ultrasol™ Magnum P44 not only higher yield but also better quality of potato tubers were obtained.

The fresh total yield of tubers was increased by 17% with Ultrasol™ Magnum P44 treatment compared with MAP. Ultrasol™ Magnum P44 also positively affected dry matter yield of potato tubers. In addition, there was a reduction in the NO_3-N content of tubers in favour of Ultrasol™ Magnum P44.

This result is most evidently due to the acidific tion effect of Ultrasol™ Magnum P44, which in turn increases P-uptake by the plant. High P-availability is particularly important for potato in the tuber initiation stage, and most probably P-uptake by the plant during the Ultrasol™ Magnum P44 treatment was higher and led to higher final yield with better quality under these conditions. Furthermore N-uptake by the plant may have been higher due to less losses of urea-N in alkaline conditions.

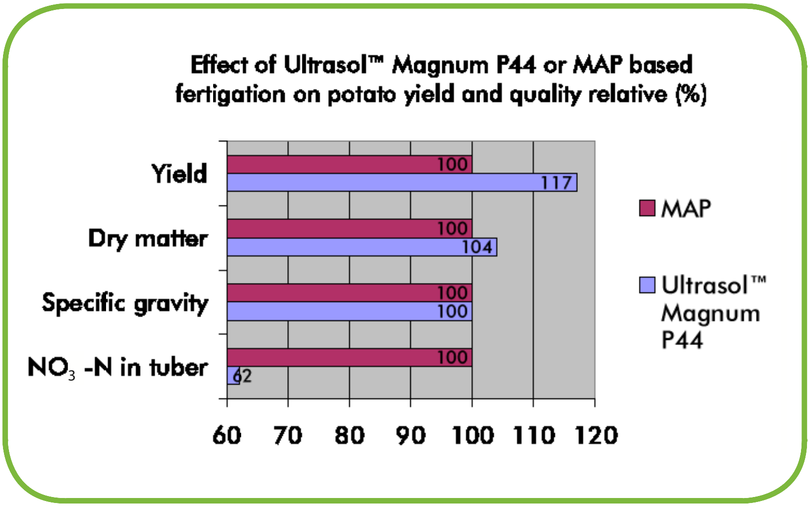


Figure 23. Effect of MAP or Ultrasol™ Magnum P44 based fertigation on potato yield and quality. Relative figu es.

Conclusions

The use of Ultrasol™ Magnum P44 in potato resulted in 17% more yield and higher dry matter content.

Detailed information about the trial

Treatments

Fertilisers and their applied dosages, all by fertigation:

Farmer's practice (kg/ha)		Test plot (kg/ha)	
MAP	425	Ultrasol™ Magnum P44	562
KNO_3	800	KNO_3	788
AN	665	AN	418
N	377	N	346
P_2O_5	259	P_2O_5	247
K_2O	368	K_2O	362

Concentrations in irrigation water: 160 ppm N, 115 ppm P_2O_5 and 168 ppm K_2O.

Plot size and replicates

Size of plot was 0,5 ha; the trial was not replicated.

Planting and harvesting dates

Potato variety used was "Spunta", the field was planted on 11th January and harvesting was done on 13th May, 1996.

Samples of tubers were taken for NO_3-N, P, K, specific ravity and dry matter analyses.

Irrigation

Irrigation and fertigation were made by mini-sprinklers. The applied irrigation water volume was 2.160 m^3 per ha which corresponds to 216 mm. The total amount and frequency of water application were the same for both treatments.

2.1.1.6 Potato - UK

General

Two fertigation trials were carried out on a loamy sand soil with relatively high pH and with alkaline irrigation water in Lincolnshire, Eastern England (most important potato growing county in the UK) in the years 2001 and 2002.

Treatments

All three treatments included drip irrigation:

1. Control – solid NPK plus ammonium nitrate (AN) topdressing.
   50% of total N and P applied by fertigation either:

2. Ultrasol™ Magnum P44 plus AN
   Applied by fertigation: 2001 – 182 kg Ultrasol™ Magnum P44 per ha;
   2002 - 205 kg Ultrasol™ Magnum P44 per ha.

3. MAP plus AN.
   Applied by fertigation: 2001 – 131 kg MAP per ha; 2002 - 148 kg MAP per ha.

All treatments had the same amount of N applied, and 50% of total N was applied as base dressing in all cases. The control treatment received all P in the base dressing. All plots had the same K and Mg application in base.

Variety Marfona was used for both trials.

Results

In the Ultrasol™ Magnum P44 plot the yield was increased with + 4,5-12,6 tonnes per ha as compared to the control treatment. Also the dry matter content increased with Ultrasol™ Magnum P44 as compared to the control, which is very important in terms of improved storage quality (Table 34).

The higher yields resulted in an additional income of + 375-1.006 € per ha as compared to the control and + 423-661 € per ha as compared to MAP (Figure 24).

Table 35 shows the differences in gross margin (€/ha) of Ultrasol™ Magnum P44 as compared to MAP and to the control in 2001 and 2002. Gross margin is defined as the crop value after deduction of variable costs, cost of drip irrigation system and of plant nutrition. Potato prices of €100 per tonne were used for these calculations.

Table 34. The effect of Ultrasol™ Magnum P44 and MAP on marketable potato yield and dry matter content of tubers in 2001 and 2002.

2001 trial	Control	Ultrasol™ Magnum P44	MAP	LSD 5 %
Marketable Yield > 35 mm	53,8	66,4	57,9	5,3
% dry matter of tubers	16,1	17,1	17,4	-
2002 trial				
Marketable Yield > 35 mm	60,3	64,8	59,5	7,6
% dry matter of tubers	16,8	18,5	17,4	-

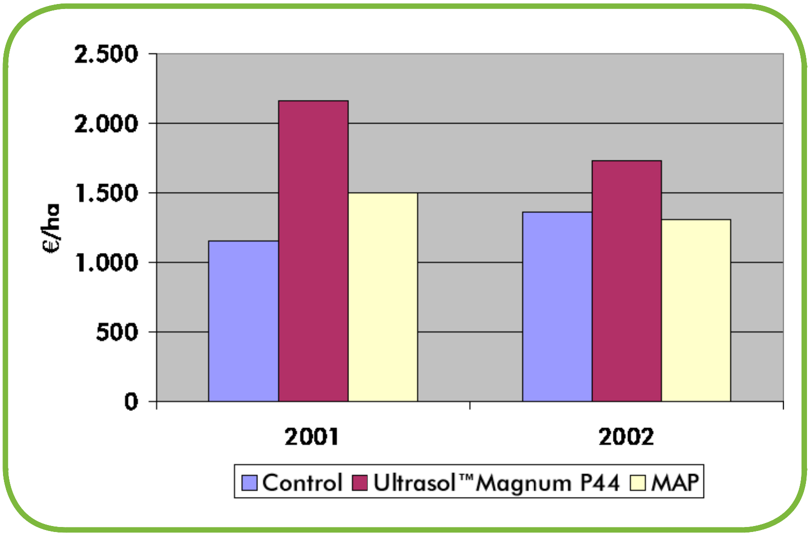


Figure 24. Additional income (€/ha) per treatment in 2001 and 2002.

Table 35. Differences in gross margin (€/ha) of Ultrasol™ Magnum P44 as compared to MAP and to the control in 2001 and 2002.

Differences in gross margin	2001	2002
	€/ha	
Ultrasol™ Magnum P44 - MAP	661	423
Ultrasol™ Magnum P44 - control	1.006	375

2.1.1.7 Sweet Pepper - Cyprus

General

The objective of this trial was to investigate the performance of various P-fertiliser sources on fertigated sweet pepper. The soil of the trial field was very calcareous and highly alkaline, its pH was 8,2. The applied irrigation water was alkaline.

The applied P-sources were monoammonium phosphate (MAP), diammonium phosphate (DAP) and Ultrasol™ Magnum P44.

The fertigation programme for all the treatments was otherwise similar and based on the current practical recommendation; the only difference was the P-source. In order to test the efficiencie of the P-sources two P-dosages were included in the trial, i.e. the local recommendation, and 25% less than that. Fertiliser applications of micro-nutrients were not made at all.

Results

There were statistically significa t differences in the performance of the treatments. In the DAP based fertilisation programme smaller fruits and less fruit setting were achieved. MAP and Ultrasol™ Magnum P44 did not differ in this sense, but the Ultrasol™ Magnum P44 based programme produced heavier fruits than MAP. For this reason the total yield in tonnes per ha was highest in the Ultrasol™ Magnum P44 treated plots, and furthermore the best result was obtained from the lower P-dosage of Ultrasol™ Magnum P44. The yield increase of this treatment compared to the local practice (MAP) was 8%.

This result is most evidently due to the acidific tion effect of Ultrasol™ Magnum P44, which in turn increases P-uptake by the plant and furthermore N-uptake due to less losses of urea-N in alkaline conditions. Additionally, it is very likely that acidific tion of alkaline soils also increased plant availability of soil micro-nutrients.

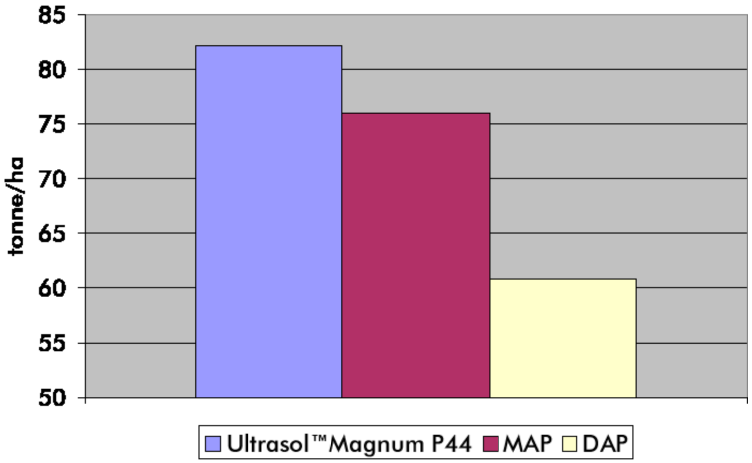


Figure 25. Effect of P-source (low P level) on sweet pepper yield (tonne/ha).

Conclusions

The use of Ultrasol™ Magnum P44 in sweet pepper resulted in up to 8% more yield compared to MAP and 35% more yield compared to DAP.

Detailed information about the trial

Treatments

The following figu es stand for concentrations of nutrients in feeding solution, N - P_2O_5 - K_2O (ppm = mg/l):

1. Ultrasol™ Magnum P44-1	120 - 115 - 240
2. MAP-1	120 - 115 - 240*
3. DAP-1	120 - 115 - 240
4. Ultrasol™ Magnum P44-2	120 - 80 - 240
5. MAP-2	120 - 80 - 240
6. DAP-2	120 - 80 - 240

* present local recommendation for sweet pepper.

Other fertiliser sources were KNO_3 and NH_4NO_3 so that the dosages of N and K were equal in every treatment.

Plot size and replicates

Size of plot was 3,6 x 6 m, and every treatment was replicated four times.

Planting and harvesting dates

Sweet pepper variety used was "Gideon", seedlings were transplanted on 4th April and final ha vesting was made on 20th September, 1996.

Irrigation

Amount of water was based on Epan evaporation starting with 0,3 and gradually increasing at full growth to full Epan evaporation. In total 330 m^3 of water was applied to the trial area which corresponds to 6.346 m^3 per ha. The fertiliser injection was started from the second irrigation and continued until the end of August.

2.1.1.8 Tomato - Cyprus

General

The objective of this trial was to investigate the performance of various P-fertiliser sources on fertigated tomato. The soil of the trial field was very calcareous and highly alkaline; its pH was 8,2-8,4. The applied irrigation water was alkaline.

The P-sources applied in fertigation were phosphoric acid (H_3PO_4), diammonium phosphate (DAP), monoammonium phosphate (MAP), and Ultrasol™ Magnum P44.

The fertigation programme for all the fertigated treatments was otherwise similar and based on the practical current recommendations; the only difference was the P-source. In this trial a special focus was set on the efficie y of the Ultrasol™ Magnum P44 and therefore a lower P dosage was included of that particular fertiliser, i.e. 75% of the present local P recommendation for tomato.

Results

The Ultrasol™ Magnum P44 treatment (with lower P dosage!) gave the highest yield in this trial. Table 36 shows the yield of tomato with different fertilisation programmes.

Table 36. The yield of tomato with different fertilisation programmes.

Treatment	Yield tonnes/ha	Relative Yield %
1. Soil application	85,4 d (*)	80
2. Fertigation 1	95,6 c	90
3. Fertigation 2	98,4 c	92
4. Fertigation 3	98,7 c	92
5. DAP-1	104,0 b	97
6. MAP-1	106,8 b	100
7. Ultrasol™ Magnum P44 -1	104,2 b	96
8. Ultrasol™ Magnum P44 -2	115,8 a	108

(*) Numbers followed by the same letter do not differ statistically significa t (P=0,05) from each other.

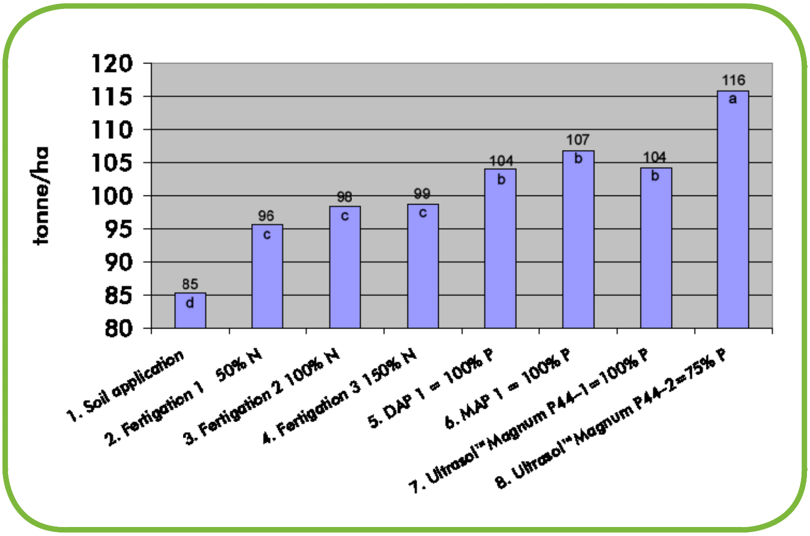


Figure 26. Yield of tomato with different fertilisation programmes.

Conclusion

The results indicate that fertigation irrespective of the combination of fertilisers is superior to soil application. Treatment 8 with Ultrasol™ Magnum P44 as a source of P gave the highest yield although P supplied was 25% less than in all the other treatments.

The P level 2 (lower) performed better than the P level 1 in the case of Ultrasol™ Magnum P44. This may be due to the fact that probably the availability of fertiliser N, P and K was unbalanced at the P level 1.

Compared with the present practice (T3), the Ultrasol™ Magnum P44 treatment gave 17,4 tonne per ha or 16% higher yield. This result was achieved by 25% less P per ha than the present P recommendation for the fertigated tomato. Lower P doses/ha can be recommended when Ultrasol™ Magnum P44 is used. This result is most evidently due to acidific tion effect of Ultrasol™ Magnum P44, which in turn increases plant P-uptake and furthermore N-uptake due to less losses of urea-N in alkaline conditions. Additionally, it is very likely that acidific tion of alkaline soil also increased plant availability of soil micro-nutrients.

Detailed information about the trial

Treatments

Soil type was described as a Pellic Vertisol (26% sand, 32% silt, 42% clay). $CaCO_3$ content 50 - 60% to depth of 90 cm, pH 8,2 to 8,4.

Fertilisation took place via drip irrigation and fertigation.

The following figu es show the concentrations of nutrients in the feeding solution per treatment (ppm = mg/l):

Treatments

1. Soil application of N, P and K + Irrigation (no fertigation)	
2. Fertigation 1	N 75, P_2O_5 108, K_2O 282
3. Fertigation 2	N 150, P_2O_5 108, K_2O 282(*)
4. Fertigation 3	N 225, P_2O_5 108, K_2O 282
5. DAP-1	N 150, P_2O_5 108, K_2O 282
6. MAP-1	N 150, P_2O_5 108, K_2O 282
7. Ultrasol™ Magnum P44-1	N 150, P_2O_5 108, K_2O 282
8. Ultrasol™ Magnum P44-2	N 150, P_2O_5 80, K_2O 282

(*) Current practice.

The nutrient sources in the different treatments were:

1	NH_4NO_3, TSP and K_2SO_4
2, 3 and 4	H_3PO_4: NH_4NO_3, K_2SO_4 and H_3PO_4
5	DAP: KNO_3 and NH_4NO_3 in addition to P-sources
6	MAP: KNO_3 and NH_4NO_3 in addition to P-sources
7 and 8	Ultrasol™ Magnum P44: KNO_3 and urea in addition to P-sources

The nutrient applications per ha are equal in the treatments with H_3PO_4, MAP and DAP meaning: 300 kg N, 216 kg P_2O_5 and 564 kg K_2O per ha. In case of Ultrasol™ Magnum P44 160 kg P_2O_5 per ha was given.

Plot size and replicates

Plot size	3,6 x 10 m
Type of experiment	Randomized blocks, four replicates

Planting and harvesting dates

One-month-old tomato seedlings of hybrid "Luxor", raised in peat compost cubes, were planted on 27th March.

Final harvesting date was 23rd August.

Irrigation

The amount of water was based on Epan evaporation starting with 0,3 and gradually increased, to full Epan evaporation at full growth. The total quantity of irrigation water was 2.000 m^3 per ha for the whole growth period, i.e. 118 days. The fertiliser injection was started from the first irrigation. With this amount of irrigation water the cumulative amount of N, P and K applied was equivalent to the amounts anticipated for each treatment.

2.1.1.9 Tomato - Turkey

General

The main objective of this trial was to compare the performances of Ultrasol™ Magnum P44 based acid NPKs with use of straight AN, MAP and KNO_3 on fertigated tomatoes. In addition, one objective of the trial was to investigate the ratios of N, P and K in tomato cultivation. The grade of NPK and also the proportions of straights were adjusted to the three growth phases of tomato.

The basic idea was to give a high P product in the beginning to enhance root growth, and then to apply more N and K for mid-season, and finally give a fertiliser with very high K at the end of the season. This variation of N, P and K during the season was also compared to two treatments where one mixture of NPKs and straights were used for the whole season.

The soil of the trial field and the irrigation water were both alkaline, and therefore expectations of the trial result were that an acidic fertiliser was to perform better due to its positive effect on soil and irrigation water.

The acid fertilisers used in the trial were:

NPK 13 - 40 - 13 + TE for the first 40 d ys after planting,
NPK 23 - 10 - 25 + TE from 40 to 110 days period, and
NPK 20 - 5 - 30 + TE for the rest of the growth season.

The nutrient levels in mg per litre in the feeding solution were equal in all treatments.

Results

The main result of the trial was that the highest yield, i.e. 155 tonnes per ha was achieved by the programme with 3 different acid NPKs. The mixtures of straights with KNO_3, AN and MAP gave slightly lower yield, and the lowest yields were obtained from the treatments with the same nutrient ratio for the whole period. However, the yield differences in this trial were not large.

Conclusion

The highest yield was achieved by the programme with 3 different acid NPKs.

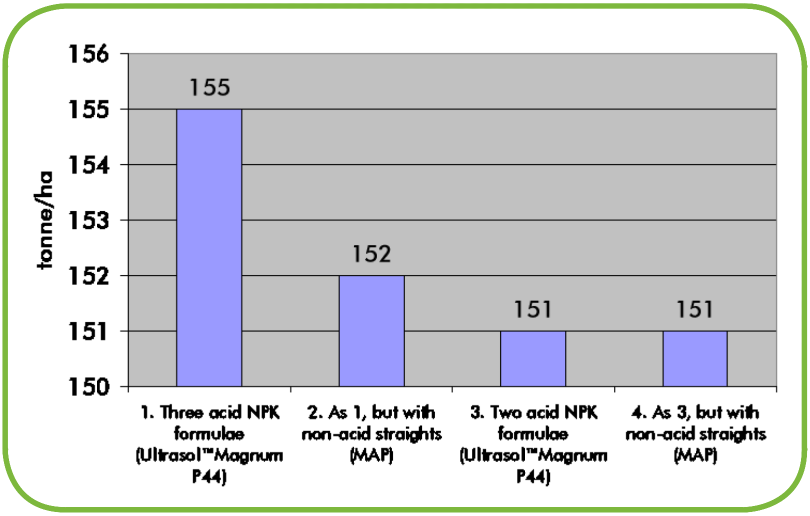


Figure 27. Tomato yield in tonnes per ha affected by various fertigation programmes.

Detailed information about the trial

Treatments

1. Acid NPK 13 - 40 - 13 for the first 40 days after planting, 23 - 10 - 25 from 40 to 110 days after planting and 20 - 5 - 30 for the rest of the season.

2. Same ratios of nutrients as in treatment 1 but fertigation programmes built up by using AN, MAP and KNO_3.

3. Same mixture of NPK 13 - 40 - 13 and NPK 20 - 5 - 30 used for the whole season.

4. Same mixture of AN, MAP and KNO_3 used for the whole season (same N, P and K ratios as in treatment 3).

Site

Antalya, Turkey.

Irrigation

The trial was drip irrigated and all the fertilisers were applied via the irrigation system.

2.1.1.10 Tomato - China (Shanghai Area)

General

A fertigation trial in the Shanghai area in China was conducted in 2001. This trial has been conducted with four varieties, and compared two fertigation regimes: a widely used local one and a balanced plant nutrition treatment, including Ultrasol™ Magnum P44 as the sole P-source. In both treatments crops received the same amount of nutrients, except for Ca, which was higher in the local treatment.

Results

The Ultrasol™ Magnum P44 treated plants displayed a more vigorous crop growth (canopy and roots), across all four varieties included in this trial. This was refle ted in:

· higher leaf chlorophyll content (Figure 28).
· increased rate of net photosynthesis (Figure 29).
· leading to higher total yield (Figure 30).

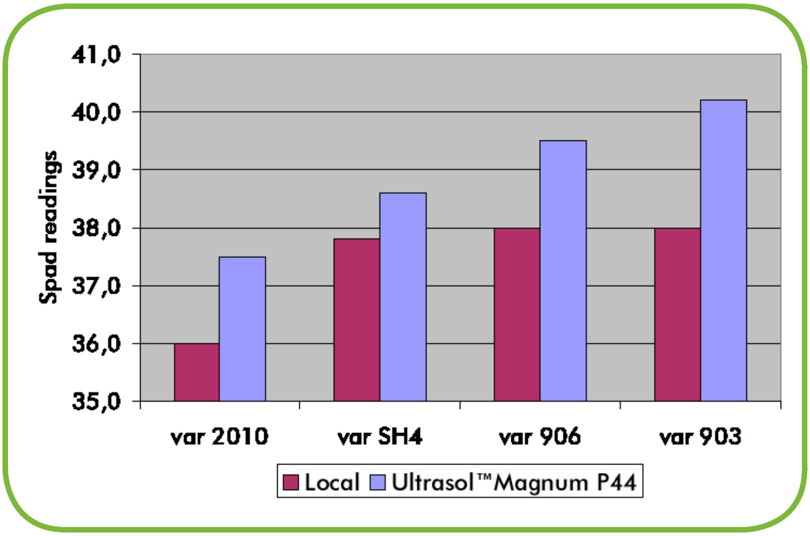


Figure 28. Effect of two fertilizer treatments on leaf chlorophyll content of four tomato varieties.

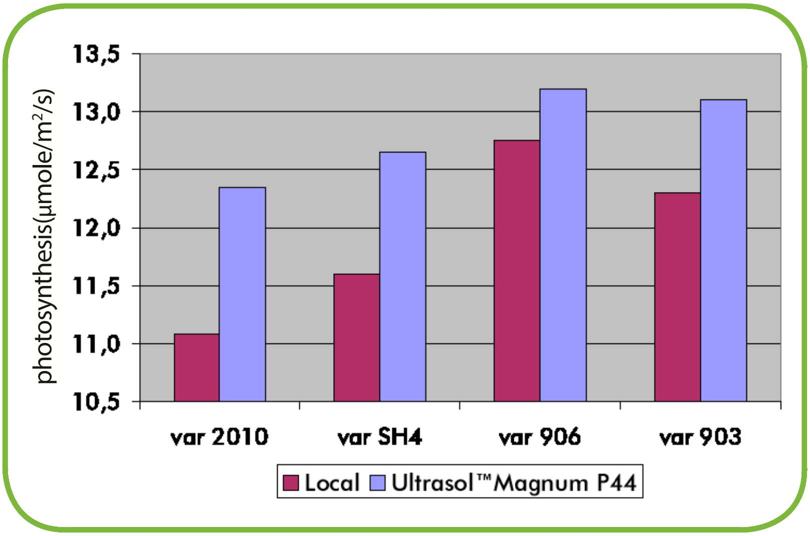


Figure 29. Effect of two fertiliser treatments on leaf net photosynthesis of four tomato varieties.

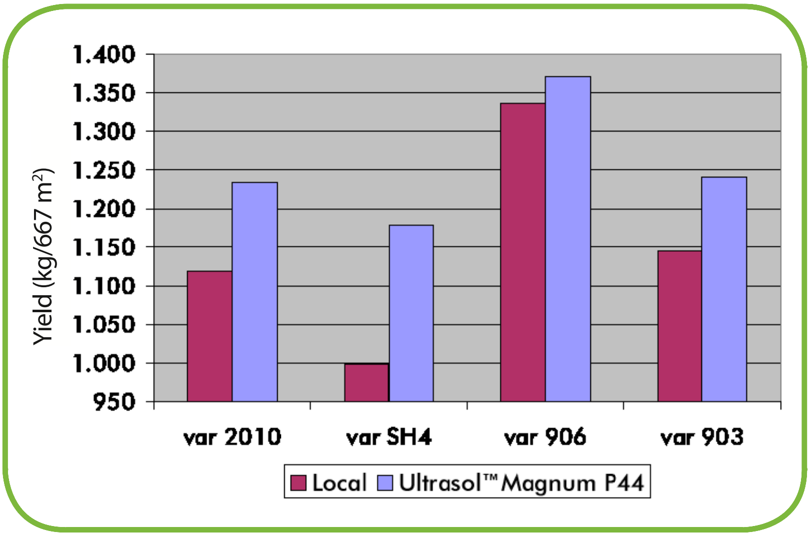


Figure 30. Effect of both fertilisers treatments on tomato yield of four tomato varieties.

Conclusion

A fertigation programme with Ultrasol™ Magnum P44 as compared to MAP gave higher leaf chlorophyll contents and increased rates of net photosynthesis, which resulted in higher yields.

Detailed information about the trial

Treatments

The standard treatment consisted of the local fertigation products, whereas the alternative treatment included Ultrasol™ Magnum P44. In both treatments all nutrient doses were equal, except for calcium (Table 37). Less calcium nitrate was applied in order to compensate for the extra N supplied via Ultrasol™ Magnum P44.

Table 37. The composition of the nutrient solutions for tomato.

	Ultrasol™ Magnum P44 treatment (mg/l)	Local fertiliser treatment (mg/l)
MKP	92	187
Potassium nitrate	620	550
Calcium nitrate	735	940
Magnesium sulphate hepta hydrate	400	400
Ultrasol™ Magnum P44	110	0
Trace element (mg/l)	8,0 Fe; 1,8 Mn; 2,3 B; 0,08 Cu; 0,22 Zn; 0,09 Mo	

The substrate was an inorganic and organic compound substrate. The volume ratio of perlite and organic manure was 9 to 1.

The chlorophyll content in the leaves was analyzed with SPAD-502 (made in Japan). The photosynthesis ratio was analyzed with CI-30PS (made in the USA).

Plot size and replicates

The trial was carried out at the horticultural research institute Shanghai Academy of Agricultural Sciences (SAAS) in a plastic greenhouse of 667 m^2. The trial had 4 replications.

Harvesting date

The harvest was finished mid July 2001

Irrigation

The nutrient solution compositions remained the same during all growth stages. In the vegetative growth stage the EC of the nutrient solution was 2,0 mS per cm and during the fruit stage it was 2,5 mS per cm. The irrigation amount of nutrient solution was adjusted according to the weather conditions. Generally, the amount was between 300-1.000 ml per irrigation per individual plant.

Discussion

The tentative explanations for the better overall performance are various, but most evident are the following ones:

Ultrasol™ Magnum P44 due to its acidity releases nutrient cations from the soil and leads to a higher and more balanced uptake e.g. of Mg and Fe. Both cations are highly important for synthesis and a proper functioning of chlorophyll. Mg plays a central role in the chlorophyll molecule and Fe is important for the so-called heme enzymes in the plants´ chloroplasts.

More chlorophyll will lead to a higher net photosynthesis (see Figure 29) and it can be anticipated that particularly under low light conditions, e.g. with shade leaves, higher photosynthetic capacity shall generate higher crop yields.

2.1.1.11 Watermelon - Greece

General

Cultivation of early watermelons is of particular importance in parts of Greece since large quantities are exported to northern European countries from late May to July. Since market prices deteriorate sharply during the season, early production is of very high importance to the grower.

From literature and from previous experimental work over a range of crops it was shown that the acidic Ultrasol™ Magnum P44 applied to calcareous soils positively affects the yield and quality of vegetable crops compared to traditional P-sources such as MAP (Monoammonium Phosphate).

In order to verify earlier results, an experiment was established in the Philiatra area with early watermelons and the two sources of phosphorous, i.e. Ultrasol™ Magnum P44 and MAP were studied in various concentrations and combinations. The experiment started under low plastic covers and continued under open field conditions, following traditional cultivation techniques.

The trial has been carried out with 7 treatments and 4 replications in a randomized complete block design. Treatments only differed in terms of P-application (P-sources Ultrasol™ Magnum P44, MAP, "local: 0-20-0 + 10-52-10" in 2 P-rates and in different combinations), whereas all other fertilisation and cropping practices remained the same. The trial was carried out on a sandy loam of rather low Olsen-extractable P. Water available for fertigation was classified as ha d water.

Results

While the total yield was not significa tly different between the three main treatments, the early yield (at the 1st harvest) of Ultrasol™ Magnum P44 treated melons was more than 45% higher compared to the two other treatments. TSS (total soluble solids, i.e. a parameter refle ting the sugar content of the fruits) was not affected at early harvests and stayed above the level of the local treatments in Ultrasol™ Magnum P44 and MAP treated melons (Figure 31).

The increased yield at 1st harvest in Ultrasol™ Magnum P44 treated melons was due to both yield components: number of fruits per plant (Figure 32) and weight per fruit.

The extra profit at growers level was calculated taking into account the market price development of melons during the respective harvesting period (June 2002) (Figure 33) and the farm gate prices (Figure 34) for those P-fertilisers, which had been under investigation. The price at the first harvest on 11th June was 0,132 €/kg, while the price dropped to 0,073 € at the second harvest on 20th June. Based on these results, the extra profit of about 1.300 € per ha as a result of using Ultrasol™ Magnum P44 as the sole P-source is obvious and this is mainly a consequence of earlier yields that can benefit from much higher market prices.

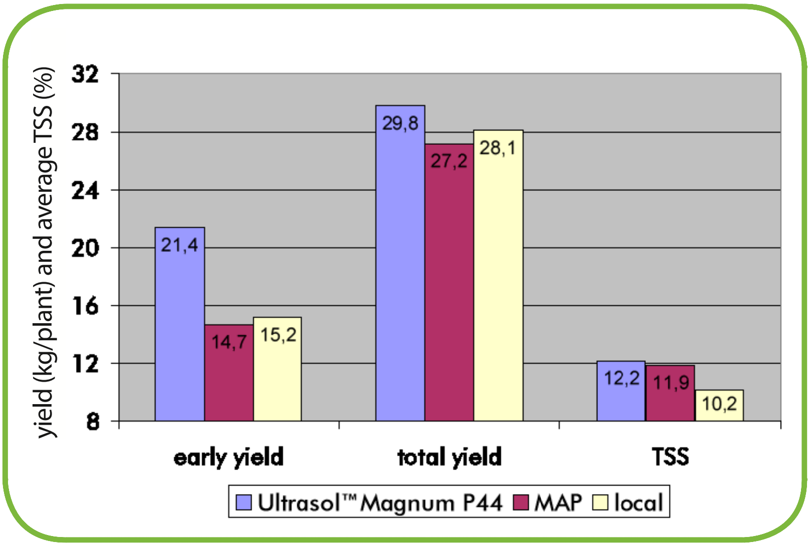


Figure 31. Effects of N/P-source on the marketable yield and TSS (mean value both harvests) of watermelons (Greece 2002). Means were compared by LSD Test. Means within columns at each treatment followed by different letters are significa tly different (P=0,05).

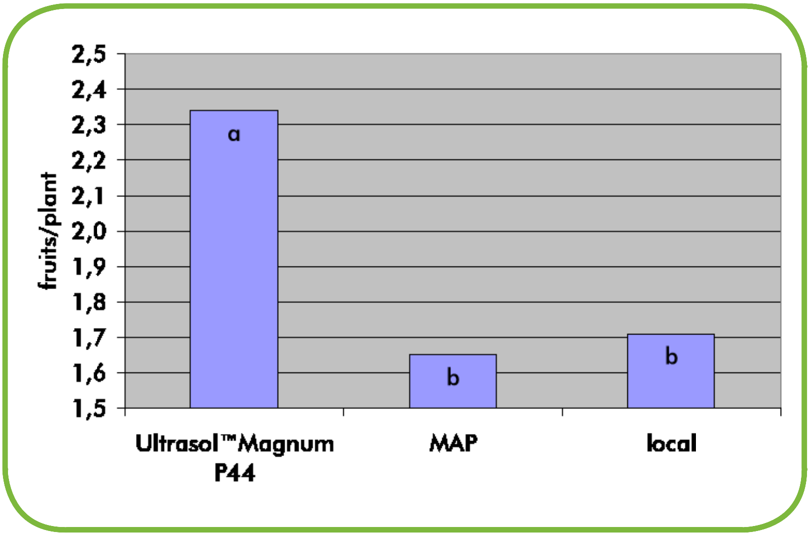


Figure 32. Effect of N/P-source on the number of fruits/plant at 1st harvest (Greece 2002). Means were compared by LSD Test. Means within columns at each treatment followed by different letters are significa tly different (P=0,05).

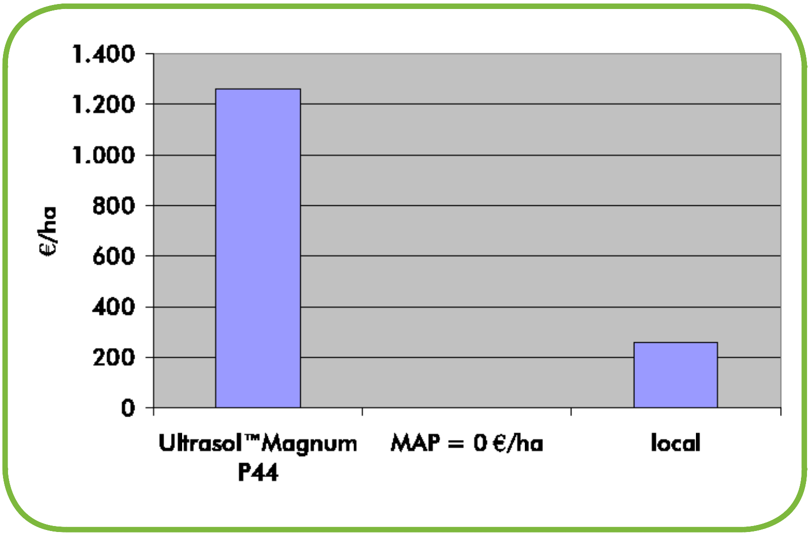


Figure 33. Effect of N/P-source on the extra profit of watermelon production (€/ha, MAP=0 €/ha, Greece 2002).

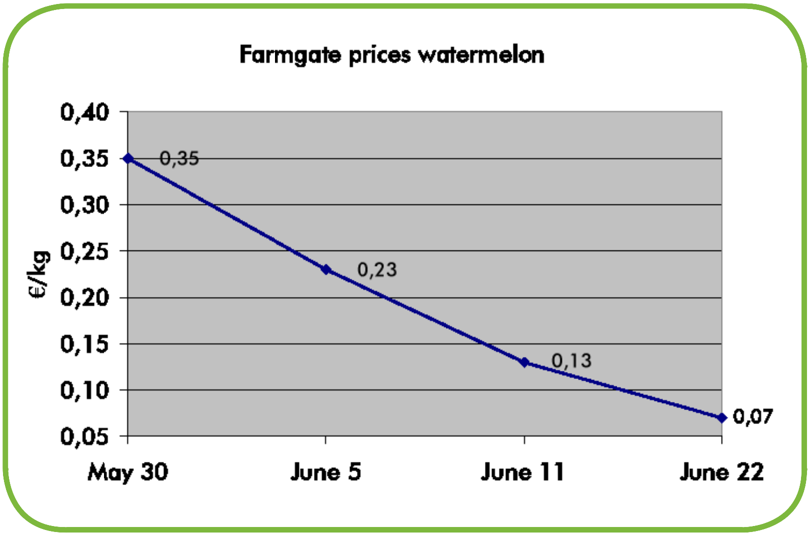


Figure 34. Farmgate prices of melons, Greece, June 2002.

Detailed information about the trial

Treatments

Watermelon, hybrid OBLA F1 (Esasem S.p.A. Casaleone-Verona Italy) grafted on SILVER rootstock (Hybrid Hellas) was used. The trial consisted of seven phosphorous treatments with different phosphorous sources and dose rates.

Table 38. The seven treatments of the experiments with the levels of total phosphorous in kg P_2O_5 per ha.

Treatment		Total phosphorous level kg P_2O_5/ ha
100% Ultrasol™ Magnum P44	100% of crop's P supply as Ultrasol™ Magnum P44 plus recommended amount of N and K	110
50% Ultrasol™ Magnum P44	50% of crop's P supply as Ultrasol™ Magnum P44 plus recommended amount of N and K	55
100% MAP	100% of crop's P supply as MAP plus recommended amount of N and K	110
50% MAP	50% of crop's P supply as MAP plus recommended amount of N and K	55
Local Control	100% of crop's P supply as basic fertiliser (0-20-0) and two applications after transplantations with 10-52-10 as starter fertiliser	110
50% Local + 50% Ultrasol™ Magnum P44	50% of P as local treatment + 50% P as Ultrasol™ Magnum P44 with the higher dose	110
50% Local + 50% MAP	50% of P as local treatment + 50% P as MAP with the higher dose	110

Plot size and Replications

The experimental design was a randomized block with four replications i.e. 10 plants per plot. The distance between rows was 3,5 m and between plants on the row 1,2 m. Guard rows were used between treatments.

Planting and Harvest Dates

The watermelon seedlings were transplanted and covered under low plastic tunnels on 4/03/02, at a plant density of 0,23 plants/m^2. Uncovering date: 29/04/2002. Harvest dates: 1st harvest 11/06/2002 and 2nd harvest 20/06/2002.

Irrigation

Drip irrigation was used with common in-line drippers with a standard fl w of 2 l/h and four drippers per plant.

2.1.2 Foliar Trials

2.1.2.1 Apples - Ultrasol™ Magnum P44 Foliar Sprays on Apples (1993-1996) - UK

Summary

Ultrasol™ Magnum P44 was applied as a foliar spray at the rate of 10 kg/ha Ultrasol™ Magnum P44 in 200 litres water per ha (5% strength w/v) four times at 7-10 day intervals. These observation trials were made in England in commercial orchards between 1993 and 1996. The spray programme was made in order to increase the P-content of the fruit at harvest; low fruit P-levels can cause Low Temperature Breakdown of fruit in stores, and this relatively high rate of product was needed in order to get suffici t P into the developing fruitlets.

The sprays did increase fruit P-levels at harvest, and in addition there were benefits seen in terms of skin colour at Golden Delicious. The trial work initially only looked at Ultrasol™ Magnum P44 on its own and not mixed with other products. In the fourth year, severe lenticel spotting occurred when Ultrasol™ Magnum P44 was tank mixed with the insecticide Dursban (chlorpyriphos), a common insecticide used by fruit growers. The fruit was badly spotted and was unsaleable.

Observations resulting from spraying a range of products with Ultrasol™ Magnum P44 confi med the damage, and it was decided to stop further work and to recommend that Ultrasol™ Magnum P44 should NOT be foliar applied to apples, as there was a considerable likelihood of farmers mixing Ultrasol™ Magnum P44 with other products.

Background

Minimum storage temperatures of apples are dictated by their susceptibility to low temperature breakdown (LTB); apples can be stored for several months between harvest and final sale in controlled atmosphere stores to stop respiration. LTB is related to mineral composition, and it was found that the P-level in the fruit was critical. Work at East Malling Research Station, Kent, England in the 1970's and 1980's showed that a range of phosphorous products could be used to increase fruit P-levels, including diluted phosphoric acid.

The main product used in the UK is Seniphos, (Phosyn PLC) which is a buffered solution of monocalcium phosphate in phosphoric acid, and it was decided to trial Ultrasol™ Magnum P44 to see whether this product would also be beneficia .

Phosphorous sprays tend to be applied at the start of fruitlet formation or even before, and traditionally around 4 sprays are applied at 7-10 day intervals. The rate of Ultrasol™ Magnum P44 used was chosen to give the recommended P-dose to the crop. It should be noted that this rate (5% strength solution – 10 kg in 200 l/ha water) was much higher than previously recommended by Kemira. The target was to apply around 2 kg/ha P (as element) per application. Ultrasol™ Magnum P44 would be sold at a price around 30% lower than Seniphos, hence the interest from farmers.

Orchards were chosen where a history of LTB had been noted, and treatments consisted generally of either Ultrasol™ Magnum P44 or Seniphos treatments. As these were commercial orchards, not all sites had areas unsprayed (control plots).

Results

Samples of fruit were analyzed for their P-content at harvest and their fi mness after being removed from storage. The target P-content varies per variety, but for Bramley, used for cooking and in fruit pies, the minimum P-requirement is 9,0 mg/100 g fresh fruit (90 mg/kg fresh), whereas for dessert apples the P-target is 11,0 mg/100 g fresh (110 mg/kg fresh).

Table 39. P-content at harvest.

Year	Site (county)	Variety	P-content at harvest (mg/100g fresh)		
			Control	Seniphos	Ultrasol™ Magnum P44
1993	Kent	Bramley	-	10,2	9,8
	Cambridge	Bramley	9,8	10,9	10,5
1994	Kent	Bramle			
	Cambridge	Bramle			
	Gloucester	Cox			
1995	Kent	Bramle			
	Cambridge	Bramle			
	Hereford	Bramle			
	Hereford	Cox			
1996	Kent	Gala			
	Kent	Jonago			
	Kent	Idarec			
	Kent	G. Delici			
	Essex	Discove			
	Essex	Cox			
	Essex	Sparta			
	Hereford	Cox			
		9 site			
Overall Means		12 site			
		14 site			

Overall the Ultrasol™ Magnum P44
P-content at harvest over the contr
12 sites, but this was suffici t to pl
The Ultrasol™ Magnum P44 and Se

Fruit Firmness at Harvest and After Storage

An indication of whether LTB has occurred, is to measure fruit firmness using a penetrometer, which measures the force needed to break the skin of the fruit and to go into a certain depth. During the first 3 years of the trials, fruit was stored between 6 months and one year under controlled atmosphere, and readings were taken when the fruit was removed from storage. In the final year readings were only taken at harvest as some dessert varieties do

Table 40. Penetrometer readings (kg).

There were only very small differences in fruit fi mness between the three treatments. For the years 1993-95 where samples were stored and inspected, no instances of LTB were found in any sample. All samples gave acceptable fi mness readings except possibly the trial in 1993 in Cambridgeshire. All three sets of samples were in fact soft but still saleable.

Fruit Colour

Colour of all fruit was assessed. In 1993-95 there was no colour difference between any of the treatments at individual sites, but there were site differences. Bramley is a green-yellow coloured apple. Background colour and % redness was assessed on the dessert varieties in 1996.

Fruit colour is assessed on a scale of 1-5, where 1 = dark green, 5 = yellow. Generally supermarkets prefer greener background fruit. The main difference between treatments was that Ultrasol™ Magnum P44 improved the colour of the Golden Delicious in Kent (less yellow) (Table 41).

Redness of the fruit was not appreciably affected by the treatments except at Essex, where the Ultrasol™ Magnum P44 orchard was more overgrown and there was more shading (less ripening and less fruit redness) (Table 42).

Table 41. Fruit background colour on a 1-5 scale (1 = dark green, 5 = yellow).

Site	Variety	Control	Seniphos	Ultrasol™ Magnum P44
Kent	Gala	-	2,7	2,8
Kent	Jonagold	2,6	-	2,6
Kent	Jored	2,5	-	2,5
Kent	G. Delicious	2,9	-	2,5
Essex	Discovery	-	3,0	3,0
Essex	Cox	-	1,8	1,8
Essex	Spartan	-	2,1	2,3
Hereford	Cox	1,4	1,4	1,4

Table 42. Fruit redness (%).

Site	Variety	Control	Seniphos	Ultrasol™ Magnum P44
Kent	Gala	-	72	75
Kent	Jonagold	49	-	43
Kent	Idared	55	-	56
Kent	G. Delicious	-	-	-
Essex	Discovery	-	55	48
Essex	Cox	-	58	57
Essex	Spartan	-	86	66
Hereford	Cox	45	45	47

Fruit Damage and Compatibilities

At the Essex site, lenticel spotting was apparent after the third spray for the Ultrasol™ Magnum P44 treatment only. The farmer's spray records indicated that Dursban (active ingredient chlorpyriphos) had been mixed with Ultrasol™ Magnum P44 in the tank for the third and fourth sprays. This is a common insecticide used by many fruit growers. An observation trial was made by making tank mixes of Ultrasol™ Magnum P44 with other pesticides and spraying trees using a knapsack sprayer. Leaf scorch and fruit damage were both assessed.

Three trees of variety Cox were sprayed on 8/7/96 with each product mix, with Ultrasol™ Magnum P44 at 10 kg per ha rate and each pesticide at the manufacturer's recommended rate. Sprays were mixed on the farm and applications made from mid afternoon to early evening using a hand held knapsack sprayer fit ed with a medium spray nozzle. The water volume used was equivalent to 200 litres per ha. Air temperature was around 20 °C with a light breeze.

Trees were assessed 10 days after spraying and scored from 0 to 5.
0 = no damage, 5 = full leaf scorch or severe skin damage to the fruit.
A score of 1,0 – 1,5 would be acceptable.

Products used included:
Chlorpyriphos (Dursban and Spannit), applied at 2 l/ha (1 l/ha in 4 way mixes)
Dursban – Dow Agroscience, Spannit – PBI (Israeli source)
Topas (Dithianon + Penconazole) – Novartis (0,5 l/ha)
Calcium chloride – 10 l/ha as 36% liquid
Seniphos – 4% N + 31% P_2O_5 + 4% Ca (Phosyn PLC)

Table 43. Damage assessment of trees sprayed with Ultrasol™ Magnum P44 *and mixtures.*

Product mix applied	Leaf 0-5	Fruit 0-5
0. Control - no spray	0,0	0,0
1. Ultrasol™ Magnum P44 + Spannit	2,7	2,0
2. Spannit + $CaCl_2$	1,0	0,0
3. Topas + Spannit	1,0	0,2
4. Ultrasol™ Magnum P44 + $CaCl_2$	2,0	1,3
5. Ultrasol™ Magnum P44 + Topas	1,0	0,0
6. Ultrasol™ Magnum P44 + Dursban	1,0	1,7
7. Ultrasol™ Magnum P44 + Spannit + $CaCl_2$	1,3	0,3
8. Ultrasol™ Magnum P44 + Topas + $CaCl_2$	1,0	1,0
9. Spannit + Topas + $CaCl_2$	1,3	1,3
10. Ultrasol™ Magnum P44 + Spannit + Topas + $CaCl_2$	1,3	1,3
11. Ultrasol™ Magnum P44 + Dursban + Topas + $CaCl_2$	1,3	1,0
12. Seniphos + Spannit + Topas + $CaCl_2$	1,0	1,3

The worst damage has come from Ultrasol™ Magnum P44 plus the two chlorpyriphos formulations. Ultrasol™ Magnum P44 plus calcium chloride also caused some scorching of leaves and slight fruit damage. Topas in mixes appears to reduce scorching damage, possibly due to wetting and sticking agents in the formulation making the product safer.

Seniphos caused some leaf scorch but little fruit damage compared to Ultrasol™ Magnum P44 (treatments 12 and 10 respectively). The formulated product would have a higher pH than Ultrasol™ Magnum P44, and it is likely that the low pH of Ultrasol™ Magnum P44 solution has caused the damage when mixed with the insecticide.

Conclusions

Foliar sprays of Ultrasol™ Magnum P44 have raised fruit P-levels slightly, giving similar results to the main formulated product used in the UK (Seniphos). At one site the sprays also improved the colour of Golden Delicious. A major drawback to using Ultrasol™ Magnum P44 on apples is that severe lenticel damage, causing brown spotting of the fruit was apparent when mixed with the insecticide chlorpyriphos. As fruit growers apply a large number of sprays and would not be willing to spray Ultrasol™ Magnum P44 on its own, it was decided not to recommend Ultrasol™ Magnum P44 sprays in view of the potential risk of crop damage and large claims against the producer.

2.1.2.2 Artichoke

Near East growers spray 3 times with 120 ppm GA3 to shift production of cv Blanc d'Hyeres from spring to early winter. However, this treatment may cause head deformation.

It was shown in many field trials using vegetative propagated material under various climatic conditions that GA3 at 60 ppm in Ultrasol™ Magnum P44 acidified solution (pH 4) was as effective as 120 ppm GA3 in tap water. Moreover, no deformed heads were produced.

Reference

Basnizki, Y., E. Goldschmit, Y. Luria, M. Itach, Z. Berg and D. Galili. 1986. Effect of acidified GA3 sprays on yield of globe artichoke (Cynara scolymus L.). Hassadeh 66:9 p. 1814-1817.

2.1.2.3 Cereals - The Use of Ultrasol™ Magnum P44 as a Foliar Fertiliser for Cereal Crops - Finland

Foliar Greenhouse Trials

Introduction	The use of Ultrasol™ Magnum P44 as a foliar fertiliser for some garden plants had been tested in greenhouse trials in the spring of 1986. The purpose of this trial was to also test the use of Ultrasol™ Magnum P44 for foliar fertilisation of cereal crops. The tests were carried out at Kotkaniemi Research Farm in the summer of 1986 with three different cereals.
Treatments	1. 0,1% Ultrasol™ Magnum P44 2. 0,5% Ultrasol™ Magnum P44 3. 1,0% Ultrasol™ Magnum P44
Replications	3
Plot size	1 x 1 m.
Trial plants	Winter wheat "Aura" sown 27th August 1985 Spring wheat "Kadet" sown 22nd May1986 Barley "Aapo" sown 30th May 1986
Sprayings	1st spraying 16th June 1986 2nd spraying two weeks after the first on 1st July 1986

Performance	The experimental areas were chosen from the border blocks of Kotkaniemi's commercial area. When the first spraying was made (16th June), the spring cereals had reached the height of 10-15 cm. and the 3-leaf stage and winter wheat was coming into ear. The spraying was carried out in sunny weather, using water in high volume to make the plant stand thoroughly wet. The second spraying was made two weeks after the first one. Damages caused by sprayings were observed (Table 44).
Results	The plant stands were checked twice and damage was assessed using the scale of 0-5 (no damage - badly damaged).

Table 44. Crop damage in two different checks. The figu es are the averages of three replicates. Sprayings were made on 16th June and 1st July.

Ultrasol™ Magnum P44		Barley		Spring Wheat		Winter Wheat	
		June 19	July 12	June 18	July 2	June 19	July 2
Treatment 1	0,1%	0,0	0,1	0,0	0,0	0,3	0,5
Treatment 2	0,5%	0,5	0,5	0,0	0,0	0,7	1,7
Treatment 3	1,0%	1,3	1,3	1,0	1,0	2,2	3,0

In spring cereals only the concentration of 1,0 % caused visible damage. In winter wheat both the 0,5 % and 1,0 % solutions caused damage, which was seen as yellowish spots in leaves. However, they were so small that they did not harm crop growth.

If the Ultrasol™ Magnum P44 foliar fertilisation is carried out in the manner of a pesticide spraying, or in combination with it, using for example 400 l water/ha, the field will receive the following amounts of nitrogen and phosphorous (Table 45):

Table 45. The amounts of nitrogen and phosphorous after one or two sprayings and with three different concentrations of Ultrasol™ Magnum P44.

Treatment	Spraying 1x (g/ha)	Spraying 2x (g/ha)
0,1%	N 72	N 144
	P 78	P 155
0,5%	N 360	N 720
	P 388	P 776
1,0%	N 720	N 1.440
	P 776	P 1.552

As the table shows, the amounts of nitrogen and phosphorous available to the plant stand are very small.

Conclusions

Ultrasol™ Magnum P44 in dilute solutions, 0,1% and 0,5%, is also suitable for foliar fertilisation of crops.

The concentration of 1,0% caused visible damage, particularly in winter wheat.
Combining Ultrasol™ Magnum P44 with different pesticide solutions has not been tried.

2.1.2.4 Cotton Foliar Programme

General

Table 46 shows a foliar programme for cotton. This programme includes Ultrasol™ Magnum P44, Ultrasol™ K and Ultrasol™ Magnit.

Since Ultrasol™ Magnum P44 is a highly acidic product it is essential to control the pH of the foliar spray solution prior to application: low pH solutions may seriously damage the crop, apart from scorching.

Foliar Programme and Results

Table 46. Demonstration trial with Ultrasol™ Magnum P44 in cotton in Brazil in 2003 and key results.

Number of applications	Crop stage	Product(s) tested	Dosage (kg/ha)	Results/impact
1	60 days after emerging	Ultrasol™ K	3,3	improved architecture, increased number of flowers; higher number and heavier weight bolls; improved phenological uniformity, higher fibre yield.
		Ultrasol™ Magnum P44	1,7	
2	65 days after emerging	Ultrasol™ K	3,3	
		Ultrasol™ Magnum P44	1,7	
3	70 days after emerging	Ultrasol™ K	3,3	
		Ultrasol™ Magnum P44	1,7	
		Ultrasol™ Magnit	2,5	
4	75 days after emerging	Ultrasol™ K	3,3	
		Ultrasol™ Magnit	2,5	

2.1.2.5 Grape Size in Combination with GA3 Foliar

Adding 1g Ultrasol™ Magnum P44 per litre (pH 2,9) to a GA3 solution enhanced the effect of GA3 on grape size and delayed maturation, whereas a citrate buffer to create a similar pH of 2,9 in solution did not show these effects.

Reference

Shulman, Y., L. Fanberstein and H. Bazak. Using urea phosphate to enhance the effect of gibberellin GA3 on grape size. Plant Growth Regulation 5:3. p. 229 - 234.

2.1.2.6 Soybean - Argentina

General

The purpose of these trials was to investigate the effect of foliar applications of Ultrasol™ Magnum P44 on soybean grain yield and its yield components. These trials were carried out on double cropping soybean, following wheat (late soybean). These scientific trials were arranged on 3 sites in the province of Buenos Aires, Argentina.

In all of these trial fields the soil was slightly acidic, pH 6 and fertility of soil was at medium level. The preceding crop was wheat, which had been fertilised with urea and DAP. For late soybean Argentinean farmers normally do not apply any fertiliser to soil before sowing and in this trial field this cu rent practice was followed.

The concentrations used were 1, 2, 2,5, 3 and 4%, all in 200 litres of water per ha. This means that the dosage of Ultrasol™ Magnum P44 applied was 2, 4, 5, 6 and 8 kg per ha. The application was made only once, at 2 - 3 leaf stage.

The following assessments were made from the trial plots: phytotoxicity of leaves, total yield, grain yield, number of pods per plant and per m^2, 1.000 grain weight, number and weight of N-fixing nodule .

Results

There were a great number of statistically significa t differences in favour of the Ultrasol™ Magnum P44. On average the highest total dry matter and grain yields were achieved from the treatments with 3% of Ultrasol™ Magnum P44, i.e. 6 kg per ha (Figure 35). The average yield increase was 540 kg per ha which means approximately 90 USD per ha more profit or the farmer.

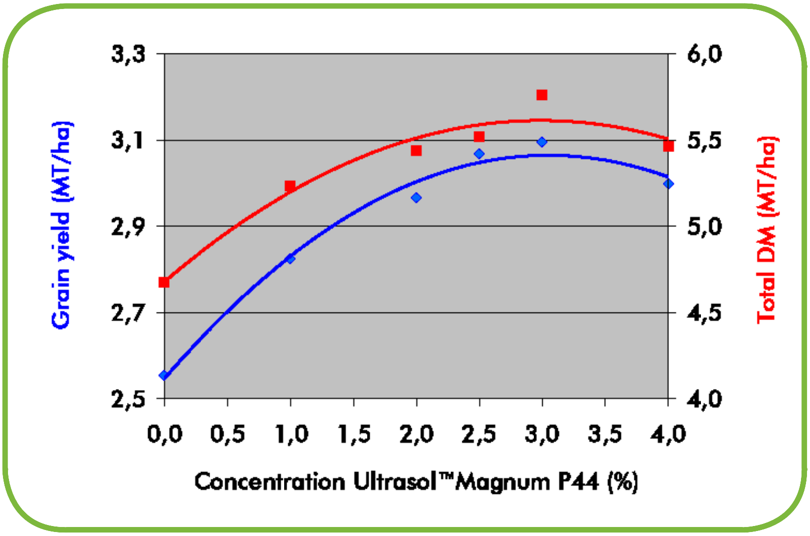


Figure 35. The effect of foliar applications with different concentrations of Ultrasol™ Magnum P44 on the grain yield and dry matter content of soybean.

Most evidently the main reason for this increase was the fact that the number of pods per plant and per m^2 were increased by Ultrasol™ Magnum P44. Also grain weight was increased to some extent. These effects were probably due to the fact that Ultrasol™ Magnum P44 increased the efficie y of N-fixing nodules. It also increased the number and individual weight of nitrogen fixing nodules. The foliar applied P is directly translocated to the N-fixing nodules. Better nodulation improved N-nutrition, resulting in more grains per pod.

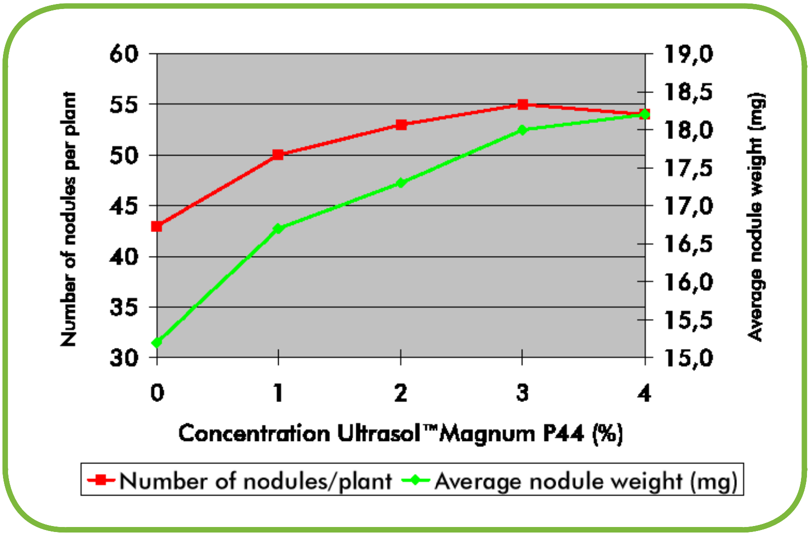


Figure 36. The effect of foliar applications with different concentrations of Ultrasol™ Magnum P44 on the number of nodules per plant and the average nodule weight of soybean.

Ultrasol™ Magnum P44 positively influen ed many yield components in these trials. The main reason may be attributed to the optimal composition of Ultrasol™ Magnum P44 with its high P-content in fully water-soluble form, and some amount of N in urea form which is very effective as a foliar application.

Application of P in plant available form is decisive at the beginning of the growth season when root development should be intensive. This may be the main reason why Ultrasol™ Magnum P44 performed so well in these trials. In addition, small amounts of N in Ultrasol™ Magnum P44 most likely contributed to a good start of growth prior to proper development of N-fixing nodule .

No phytotoxicity effects were observed in any treatments in these trials.

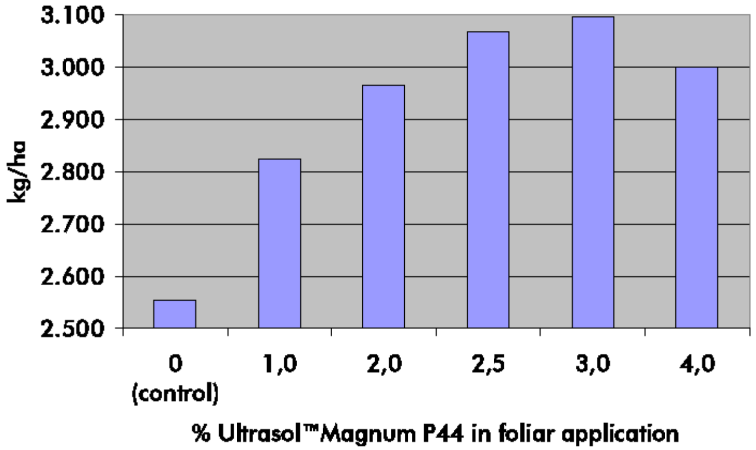


Figure 37. The effect of Ultrasol™ Magnum P44 foliar application on grain yield of 5 soybean varieties, 3 sites average, Argentina.

Detailed information about trials

Trial sites

Murphy, Urquiza and Arequito, Province of Buenos Aires

Varieties

Murphy: Nidera 5434 RG
Urquiza and Arequito: Nidera 6001 RG

Treatments

1. Control
2. Ultrasol™ Magnum P44 at 1,0% concentration
3. Ultrasol™ Magnum P44 at 2,0% concentration
4. Ultrasol™ Magnum P44 at 2,5% concentration
5. Ultrasol™ Magnum P44 at 3,0% concentration
6. Ultrasol™ Magnum P44 at 4,0% concentration

The amount of water used was 200 l per ha and consequently the amount of Ultrasol™ Magnum P44 applied was: 2, 4, 5, 6 and 8 kg per ha.

The application was made on January 18th, 17th and 15th, respectively in Murphy, Urquiza and Arequito when soybean was in a vegetative stage of 2 - 3 leaves (V2 - V3). The application was made during late evening when relative humidity was high. An adjuvant was used at 270 ml per ha.

Replications and plot size

There were 6 replications in each trial. Plot size was 50 m^2.

Assessments

Phytotoxicity effects of the foliar sprays were evaluated 7 days after the treatments were applied.

N-fixing nodules were counted and weighted at onset of blooming. The number of plants and pods, weight of 1.000 grains and total yield were measured after harvesting.

Planting dates

Murphy and Urquiza: 8th December, 1999
Arequito: 12th December, 1999

Harvesting dates

Urquiza: 8th April, 2000
Murphy: 27th April, 2000
Arequito: 22nd May, 2000

Reference

http://www.fertilizar.org.ar/articulos/Fertilizacion%20Foliar%20en%20Soja.htm

2.1.2.7 Soybean – Foliar Applications of Ultrasol™ Magnum P44

General

A trial in soybean was carried out at four different locations in Argentina. At two locations the trials were done in the first planting, and at two locations the trials were done in the second planting (Table 47).

Locations of the first pla   ting: Va. Da Fonte and Manantiales (Pergamino).
Locations of the second planting: Arequito (Santa Fe) and Alberti (Buenos Aires).

Table 47. Agronomic characteristics and soil fertility status of the trial sites.

Location	Variety	Soil Preparation (*)	Sowing date	Preceding crop	Spacing (cm)
V. Da Fonte	Nidera 924	SD	23/9	wheat/soybean	70
Manantiales	Nidera 6401	LC	21/11	soybean	70
Arequito	Nidera 6401	SD	18/12	wheat	70
Alberti	Nidera 4952	SD	07/12	wheat	52

Location	CEC meq/100 g	pH	O.M. ppm	P ppm	K ppm	Mg ppm	Ca ppm	S ppm	B ppm	Zn ppm
V. Da Fonte	12,2	6,2	3,4	3	418	200	1.983	9	0,4	0,8
Manantiales	13,2	6,1	2,6	21	817	414	4.058	13	0,2	0,7
Arequito	12,3	6,1	3,0	60	857	225	1.399	12	0,4	2,6
Alberti	14,9	6,2	3,3	21	1.018	253	1.605	13	0,5	1,7

(*) SD= direct drilling   LC= conventional tillage

Treatments

The trial consisted of one witness plot without any fertiliser application and four treatments, corresponding with two doses of two products:
a) Ultrasol™ K (13,5 - 0 - 45,5) and
b) a combination of Ultrasol™ K with Ultrasol™ Magnum P44.

The product doses and concentrations per treatment are shown in Table 48. Applications were done manually with a knapsack sprayer. In all treatments the application took place in the phenological phase R-3, which is at the beginning of bean differentiation.

The different treatments were carried out in a randomized block design, with six replications, in blocks of 25 m^2 (5 m x 5 m).

Table 48. Details about the treatments.

Treatment	Ultrasol™ K kg/ha	Ultrasol™ Magnum P44 kg/ha	Dilution l/ha	Concentration %		Moment of application
1	-	-	-	-	-	-
2	10	-	200	5	-	R3
3	10	-	120	8	-	R3
4	7,5	2,5	120	6	2	R3
5	5	5,0	120	4	4	R3

Results and Discussion

Table 49 shows the soybean yield per foliar treatment and per location. Foliar application of mixes of Ultrasol™ K and Ultrasol™ Magnum P44 resulted in statistically significa t differences in yield. There was no interaction between treatment and trial location, which allows us to make generalized conclusions about the behaviour of the products.

Both Ultrasol™ K treatments, applied in a single application, resulted in a statistically significa t higher yield than the treatment without foliar application. There was no significa t difference between the doses or concentrations of potassium nitrate, applied in a single application.

The result of the mix between Ultrasol™ K and Ultrasol™ Magnum P44 depended on the concentrations in the mix applied. The combination of 4% of each product gave the lowest yield among the four foliar treatments, whereas the mix of 6% Ultrasol™ K and 2% Ultrasol™ Magnum P44 resulted in a statistically significa t higher yield than all other treatments.

Table 49. Soybean yield per foliar treatment and per location.

Treatment	Arequito	Alberti	V. Da Fonte	Manantiales	Average
Witness	2.789	3.034	3.557	3.746	3.282 c
Ultrasol™ K 5%	3.131	3.414	4.246	4.001	3.698 b
Ultrasol™ K 8%	2.960	3.431	3.917	4.199	3.627 b
Ultrasol™ Magnum P44 2% Ultrasol™ K 6%	3.510	3.408	4.652	4.299	3.967 a
Ultrasol™ Magnum P44 4% Ultrasol™ K 4%	2.851	3.260	3.885	4.048	3.511 bc
Treatment effect (F)	2,11 *	0,76	4,29**	1,94 NS	7,19
V.C. (%)	15,9	14,4	12,1	9,1	12,7
LSD	585	573	595	447	264

**Statistically significa t difference at p = 0,01. (Different letters within a column indicate a statistically significa t difference). NS = non significa t.

Conclusions

The mix of 2% Ultrasol™ Magnum P44 and 6% Ultrasol™ K resulted in a statistically significa t higher yield than all other treatments. The results are consistent with other trials carried out in soybean with Ultrasol™ K and Ultrasol™ Magnum P44.

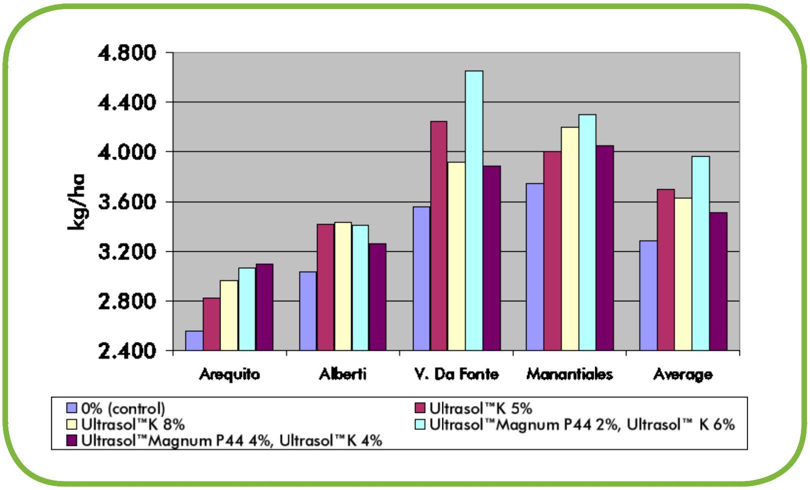


Figure 38. The effect of four treatments of foliar applications of Ultrasol™ K with or without Ultrasol™ Magnum P44 in two concentrations and two spraying volumes on the soybean yield per location.

2.1.3 Manual Applications

Peach Trees - France

General

The objective of this trial was to investigate the effect of manure application with and without Ultrasol™ Magnum P44 and its dosage on yield and quality of peach trees in the firs years of their production. The peach varieties in these trials were Dolores and White Lady.

The trial was drip irrigated but not fertigated. Fertilisers were applied manually around the trunk of the tree. The control treatment did not receive any fertilisation. The trial was arranged in the years 1992 and 1993.

Results

All fertiliser treatments performed clearly and statistically significa tly better than the control in terms of number of total and fertile fl wers, fruit weight and number of fruits per tree. The positive effect of fertilisation was detected also in fruit quality.

On variety White Lady the highest yield per tree was collected from the treatment "manure + Ultrasol™ Magnum P44", although the difference between fertiliser treatments was not significa t. The heaviest fruits were produced as a result of treatment with Ultrasol™ Magnum P44 only.

Also, on variety Dolores it was shown that "manure + Ultrasol™ Magnum P44" performed best in terms of number of fruits and total yield per tree. The best fi mness of fruits of the variety White Lady was achieved by using Ultrasol™ Magnum P44 with manure or alone.

The trial shows how important the manure is during the plantation as well as high soluble NP-fertiliser - in this case Ultrasol™ Magnum P44 - spread directly to the root area of the trees. It appears that a good combination of fertilisers gives the best result.

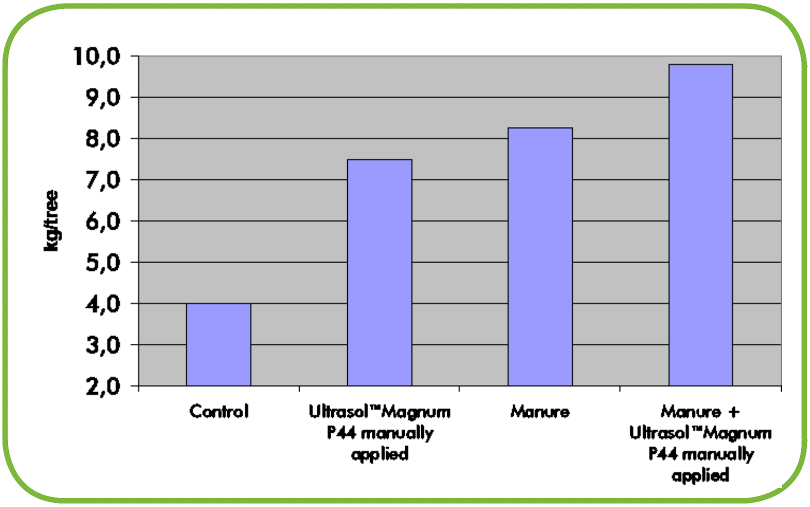


Figure 39. The effect of different fertilisation programmes on peach yield (White Lady).

Detailed information about the trial

Treatments

1. Control, no fertilisers.
2. Ultrasol™ Magnum P44, spread manually around the trunk, 4 x 100 g per tree.
3. Manure application.
4. Manure + Ultrasol™ Magnum P44, spread manually around the trunk, 4 x 100 g per tree.

Dates of Ultrasol™ Magnum P44 spreading

1992: 14th April, 7th May, 22nd May and 9th June.
1993: 14th April, 13th May, 6th June and 10th July.

Trial established and harvesting dates

Trial was established 17th January 1992 and final harvesting was made on 10th July 1993.

Irrigation

Trial area was drip irrigated.

Observations

The diameter of trunks was measured at the end of the first and second year. Yield and fruit quality were measured in 1993. For fruit analyses, 25 fruits per treatment were collected.

2.1.4 Dipping

2.1.4.1 Tomato and Sweet Pepper - Root Dipping for Enhanced Early Growth

General

In order to strengthen vegetable seedlings prior to transplanting stage, various dipping experiments have been undertaken with tomato and sweet pepper seedlings at the Espoo Research Centre in Finland. At transplanting stage and even several weeks beyond that stage seedlings are quite susceptible to biotical and a-biotical stress factors which lead to poor and delayed performance and even to death, depending on type and strength of the respective stress.

Results

The dipping experiments involved a series of Ultrasol™ Magnum P44 and MAP-concentrations (0 - 2 and 0 - 3%) and one to three successive dips of young plantlets in 1 week intervals. The main results of this experiment are as follows:

a) sweet pepper seedlings responded best to 0,25% Ultrasol™ Magnum P44 concentrations (3 dips with 1 week intervals in between, starting from cotyledon stage) (Figure 40). Growth enhancement was likely due to improved nutrition. Concentrations above 0,5% affected root growth. MAP was less toxic than Ultrasol™ Magnum P44 at higher concentrations.

Figure 40. Sweet pepper seedlings at the end of the experiment, 20 days after the first immersion, 3 eekly immersions, solution strength: 0,25%.
From left to right: MAP – Ultrasol™ Magnum P44 – control (water).

b) tomato seedlings responded best to 0,2% Ultrasol™ Magnum P44 concentrations, both, in experiments with one and with two dips. Seedlings treated with Ultrasol™ Magnum P44 at this concentration were much greener and displayed stronger root development compared to those dipped into 0,2% MAP solution. MAP was less toxic than Ultrasol™ Magnum P44 at the highest concentration (2%). In general these results demonstrate that dipping treatments with nutrition solutions such as Ultrasol™ Magnum P44 may successfully enhance plantlet development. Risks such as a negative plantlet/root performance due to the inherent characteristics of the products (mainly low pH, ammonia) have to be kept in mind.

2.1.4.2 Sweet Pepper - Root Immersion for Enhanced Early Growth

The immersion of plantlets roots in a solution of 5 grams Ultrasol™ Magnum P44 per litre enhanced their growth and development (Figure 41).

Root immersion of seedlings in trays may not be the most practical solution. Therefore a foliar application is applied, after which the leaves are washed off with water to avoid any possible leaf damage and to ensure that the product moves with the water fl w to the root. During transplanting to the field the t ays could be immersed.

Figure 41. The effect of root immersion in a solution of 5 g Ultrasol™ Magnum P44 per litre on the early growth of pepper plantlets.

2.2 Specific Target Trials

2.2.1 Anti-Clogging Trial

General

Ultrasol™ Magnum P44 is used as a fertiliser in drip irrigation. Due to the strong acidity of the product it is proven that the product itself is a very valuable source of water amendment, removing bicarbonates from hard water sources.

Moreover it has been argued that problems relating to chemical clogging of drippers and lines can be avoided. Field observations such as the one shown in the picture below (Figure 42) very often confi med such statements. It must be underlined here that clogging of lines and drippers is a constant threat to growers. Flow-rate variation due to clogged lines immediately impacts on distribution uniformity of water and nutrients and thus has a direct negative agronomic, commercial and environmental impact.

Figure 42. Drip lines of a fertigation system in a tomato field trial in Crete, Greece (2002): The lines on the left had been constantly supplied with MAP, on the right with Ultrasol™ Magnum P44 over the trial period. All other treatments remained the same. The higher amounts of precipitates in the MAP treated lines is obvious.

Cemagref trial: Proving anti-clogging effects

The objectives of these tests were to verify this point. The tests have been conducted in the irrigation testing centre of Cemagref of Aix en Provence, France.

Treatments

The key parameter under investigation was to monitor the fl w rate in time of a series of various commonly used different drippers (D1 to D5) treated with three different P-sources (P1 to P3) at three different concentrations (C1 to C3) (Table 50).

Table 50. The fl w rate in time of a series of various commonly used different drippers (D1 to D5) treated with three different P-sources (P1 to P3) at three different concentrations (C1 to C3).

Treatment	Trademark	Model	Type	Nominal range of working pressure	Nominal Flow Rate
D1	Netafim	Basic	NSC (1)	1 bar	2 l/h
D2	Netafim	Basic	NSCR	1 bar	4 l/h
D3	Netafim	PCC NL	SC (2)	1 to 4 bar	2 l/h
D4	Netafim	PCC NL	SC	1 to 4 bar	4 l/h
D5	T Tape	Gaine	NSC	0,56 bar	1 l/h

P1: Ultrasol™ Magnum P44
P2: MAP
P3: Water (control)
C1: high (1.000 ppm of P_2O_5)
C2: medium (200 ppm of P_2O_5)
C3: low (20 ppm of P_2O_5)
(1)= NSC (non self compensating)
(2)= SC (self compensating)

The total duration of each treatment was 5 days, in order to observe mineral deposits at dripper outlet. To increase the development of such precipitates, work and break cycles have been introduced, in order to allow for the drying of the solution at the outlets of the drippers.

Results

None of the treatments – not even the hard water control treatment without any additions of P-fertilisers – resulted in a significa t reduction of the emitter's fl w rates over the given period of 5 days.

Most probably the time between work and break phases was too short to achieve a complete evaporation of the water media. Moreover the duration of each treatment needs to be extended to approximately 1-2 months. Under such a long duration of the trial, specific arrangements have to be made in order to assure that chemical characteristics of the solution stay constant.

Drippers and lines have been investigated for deposits at the ESPO Research Center after termination of the Cemagref trial. These investigations gave some trend results:
The main precipitates from Ultrasol™ Magnum P44 and MAP in hard alkaline water were dicalcium phosphate dihydrate, $CaHPO_4*2H_2O$ at pH <7 and hydroxy-apatite, $Ca_5(PO_4)_3OH$, at pH>7. Some $CaCO_3$ and SiO_2 were also found in the analysed solid samples at medium or high pH. A summary of the main solids formation at various concentrations is shown in Table 51.

Table 51. Solids in drippers, pipes and feed solutions with Ultrasol™ Magnum P44 or MAP.

	pH < 6.5	pH 6.5 - 7	pH 7 - 7.5	pH > 7.5
1.000 ppm P_2O_5 as Ultrasol™ Magnum P44	No solids			
200 ppm P_2O_5 as Ultrasol™ Magnum P44		No solids		
20 ppm P_2O_5 as Ultrasol™ Magnum P44				$Ca_5(PO_4)_3OH$ $CaCO_3$, SiO_2
1.000 ppm P_2O_5 as MAP		$CaHPO_4*2H_2O$		
200 ppm P_2O_5 as MAP			$Ca_5(PO_4)_3OH$	
20 ppm P_2O_5 as MAP				$Ca_5(PO_4)_3OH$

However, a consequent difference was seen in the amount of accumulated solids inside the drippers and pipes in favour of Ultrasol™ Magnum P44. The pH and the concentration are the most dominating factors in the formation of solids.

The acidity of MAP was too low to avoid formation of precipitates at any concentration. The acidity of Ultrasol™ Magnum P44 was suffici t to avoid precipitates at 200 – 1.000 ppm P_2O_5. At 20 ppm P_2O_5 the high pH caused various precipitates also with Ultrasol™ Magnum P44.

At equal pH 6,5 - 7 the concentration of 1.000 ppm P_2O_5 as MAP induced precipitation while 200 ppm P_2O_5 as Ultrasol™ Magnum P44 was free of solids. Less solids were observed when using the self-compensating drippers or the higher fl w rate (4 l/h). Inside the pipes the precipitate was seen mainly on the opposite side to the dripper.

Figure 43. Self compensating drippers (2 litre/h) with Ultrasol™ Magnum P44 (200 ppm P_2O_5) at top and MAP (200 ppm P_2O_5) at bottom.

Conclusion

Ultrasol™ Magnum P44 helps to keep nozzles and drippers clean.

2.2.2 Earliness in Cucumber

2.2.2.1 Earliness in Cucumber - Germany

General

This research project has been conducted in cooperation with the University of Hohenheim, Germany (2003 - 2004).

The objective of this study was to evaluate the effect of Ultrasol™ Magnum P44 fertigation on induction of plant earliness on a calcareous soil, using cucumber (Cucumis sativus L.) as a model plant. Based on the inherent chemical differences of Ultrasol™ Magnum P44 and MAP fertilisers, potential effects of Ultrasol™ Magnum P44 fertigation on rhizosphere pH, root growth, nutrient availability, plant nutritional status and hormonal balances were investigated in model experiments under controlled environmental conditions.

Originally this research cooperation had been set up into 3 phases (2003 to 2006) but was terminated right after the first phase in 2004

Results

In the first phase the earliness phenomenon was confi med (comparison between 2 P-sources i.e. Ultrasol™ Magnum P44 and MAP). Key results of the first experiment were as follows:

- Increased root growth of the Ultrasol™ Magnum P44 - treated crop.
- Increased ratio of female/male fl wers in cucumbers treated with Ultrasol™ Magnum P44.
- Continuous acidific tion of the fertigation zone.

Figure 44. Left: MAP treated cucumber trial, 45 days after transplanting. Right: Ultrasol™ Magnum P44 treated cucumber trial, 45 days after transplanting: earliness of plant development in Ultrasol™ Magnum P44 treated plots is obvious.

Conclusions

Since significa t differences in nutrient uptake between both treatments were not detected, the earliness effect was tentatively ascribed to signal effects. In short, the conclusions of this first phase ere:

- Ultrasol™ Magnum P44 action on early fl wering seems to be mediated rather by signal effects than by alterations of the plant-nutritional status.
- Increased ratio of female/male fl wers may indicate involvement of ethylene as a putative signalling compound.
- Low pH of the fertigation solution seems to be a major stimulus for induction of plant earliness.

Detailed information about the trial

Treatments

Two experiments with Ultrasol™ Magnum P44 were carried out. The objectives of the experiments shown here were to evaluate the effect of Ultrasol™ Magnum P44 on
(i) soil pH in the fertigation zone on a calcareous soil.
(ii) to investigate related changes in plant development in terms of root growth, fl wering and plant nutritional status.
(iii) to separate the potential effects of N-form and pH in Ultrasol™ Magnum P44 and in MAP fertigation solutions.

Modific tions of pH in the fertigation zone

At 26 DAT, no clear effect of the Ultrasol™ Magnum P44 application on soil pH in the fertigation zone could be observed, although pH seemed to be slightly lower in the firs minutes after fertigation, compared to the other two treatments (Figure 45).

However, after 48 DAT, Ultrasol™ Magnum P44 application induced a transient drop in pH by approximately 1,0 pH unit, which was buffered to pH 6,5 within 50 minutes (Figure 46).

Therefore, it seems that the continuous acidific tion of the fertigation zone during the culture period started to exhaust the buffering capacity of the soil in this zone, leading to a later and incomplete recovery of the initial soil pH after a longer period of fertigation.

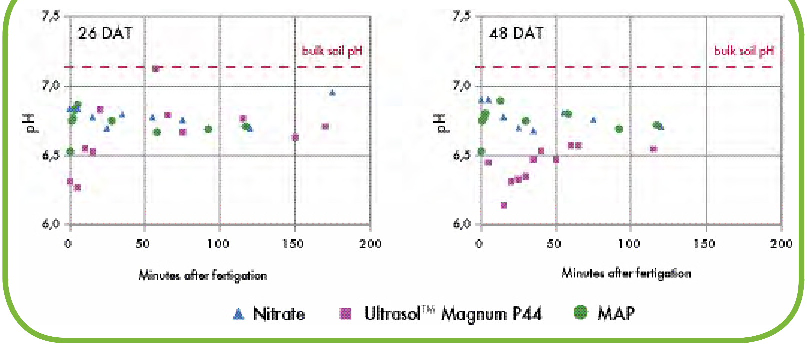


Figure 45. Soil pH in the fertigation zone, as affected by the fertigation solution with different forms of nitrogen (nitrate; Ultrasol™ Magnum P44; MAP = monoammonium phosphate at 26 and 48 DAT).

Effect of different N-sources and pH levels on fl wer development

The Ultrasol™ Magnum P44 treatment accelerated fl wer development after 45 DAT (Figure 46) and promoted the formation of female (pistillate) fl wers. The ratio of female/male fl wers was increased by 40% in the Ultrasol™ Magnum P44 treatment (4,0) compared to the MAP treatment (2,9). This finding may indicate a potential involvement of ethylene in Ultrasol™ Magnum P44 effects, as a signal which mediates female fl wer development in cucumber.

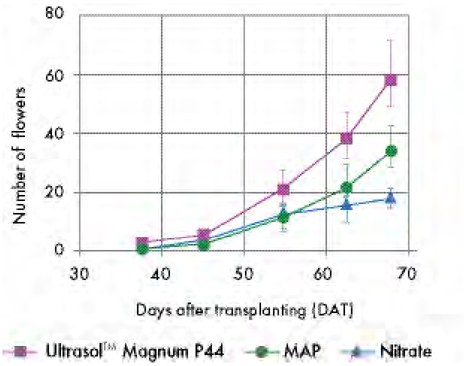


Figure 46. Number of fl wers developed at 39, 45, 55, 62 and 67 DAT in cucumber plants, as affected by fertigation with different forms of nitrogen (nitrate; Ultrasol™ Magnum P44; MAP = monoammonium phosphate).

Flowering seems to be stimulated by a low pH in the Ultrasol™ Magnum P44 fertigation solution (Figure 47). A similar effect of stimulated fl wering could be observed in the nitrate treatment at a pH of 3,0 at 30 and 32 DAT. Ultrasol™ Magnum P44 and MAP treatments at pH 4,5 or higher resulted in a same rate of fl wer development which was lower than at pH 3,0. These findings suggest that the pH of the fertigation solution is a major determinant for induction of early fl wering in cucumber.

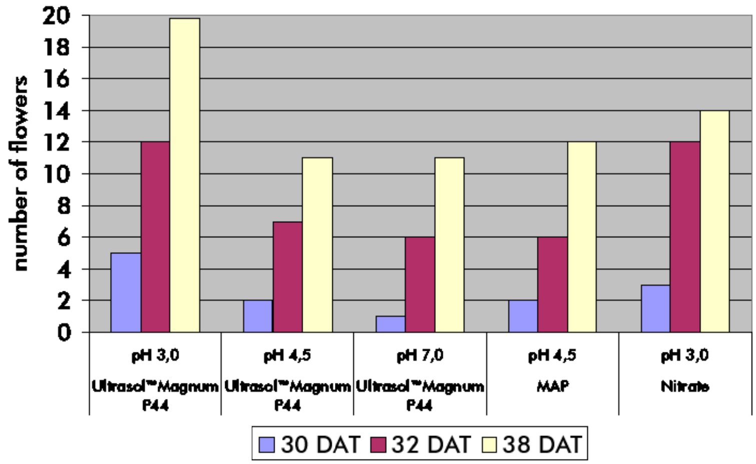


Figure 47. Number of fl wers developed at 30, 32 and 38 DAT in cucumber plants, as affected by fertigation with different forms of nitrogen (nitrate; Ultrasol™ Magnum P44; MAP = monoammonium phosphate).

Conclusions

1. The influen e of Ultrasol™ Magnum P44 on early fl wering seems to be mediated rather by signal effects than by alterations of the plant nutritional status.
2. The increased ratio of female to male fl wers may indicate an involvement of ethylene as a putative signalling compound.
3. A low pH of the fertigation solution seems to be a major stimulus for the induction of plant earliness.

A modified orking hypothesis can therefore be postulated:

Repeated application of the acidic Ultrasol™ Magnum P44 fertigation solution, finall exceeding the soil buffering capacity, exerts a kind of localized stress treatment to the roots in the fertigation zone, originally adapted to a high soil pH. Repeated reception of this treatment induces a root to shoot signal which stimulates generative growth.

2.2.2.2 Earliness in Cucumber - Mexico

General

A trial in Mexico with fertigated cucumber showed that Ultrasol™ Magnum P44 stimulates earliness in cucumber as compared to MAP (Figure 48).

Earliness in production results in earlier harvests with equal to higher physical yield and better product quality.

Figure 48. Ultrasol™ Magnum P44 stimulates earliness in cucumber as compared to MAP.

2.2.3 pH Lowering Effect in the Soil

General

In a trial with two soil types, the effect of urea and Ultrasol™ Magnum P44 at two different dose rates on the soil pH was studied (Figure 49).

An incubation trial was conducted to investigate the soil pH effect of Ultrasol™ Magnum P44. Two soils, loamy sand (pH 5,8) and silty loam (pH 7,2) were used in this trial at a rate of 200 g soil filled into a polyethylene jar. Urea and Ultrasol™ Magnum P44 were applied at rates of 30 and 60 mg N/jar dissolved in 30 ml deionised water to the soil surface. The amount of phosphorous applied with Ultrasol™ Magnum P44 was balanced with TSP (Triple Super Phosphate) in the urea treatments.

The soils were incubated at 22 – 25 °C and 60% of maximum water holding capacity, which corresponds to field capacity under open field conditions. Soil pH was analysed 3, 7 and 14 days after fertiliser application.

Results

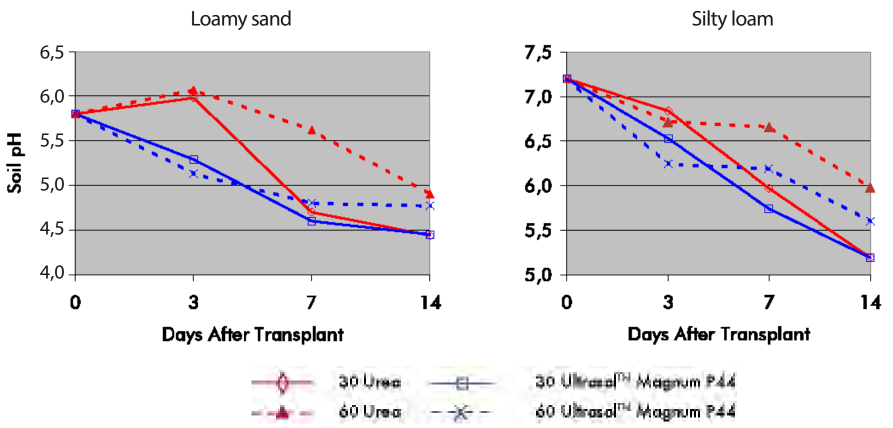


Figure 49. The effect of urea and Ultrasol™ Magnum P44 at two different dose rates on the soil pH of two soil types.

Conclusion

The use of Ultrasol™ Magnum P44 resulted in an immediate, faster and steeper drop in soil pH than urea for both soil types.

Reference

Impact of Ultrasol™ Magnum P44 on urease inhibition and volatilization losses. 2005. Research Centre Hanninghof.

2.2.4 Reduced N-Volatilization with Ultrasol™ Magnum P44

General

The use of Ultrasol™ Magnum P44 results in a double soil acidifying action. Ultrasol™ Magnum P44 affects the pH of the soil in the following two ways:

- Direct acidific tion of immediate action due to its low pH.
- Indirect acidific tion induced by urea hydrolysis.
- Urea under drip irrigation is rapidly hydrolyzed in the soil to ammonium and then oxidized to nitrate:

$$CO(NH_2)_2 + 3\,H_2O \rightarrow 2\,NH_4^+ + 2\,OH^- + CO_2 \quad \text{(reaction 1)}$$
$$2NH_4^+ + 3\,O_2 \rightarrow 2\,NO_2^- + 2\,H_2O + 4\,H^+ \quad \text{(reaction 2)}$$
$$2\,NO_2^- + O_2 \rightarrow 2\,NO_3^- \quad \text{(reaction 3)}$$

$$CO(NH_2)_2 + 4\,O_2 \rightarrow 2\,NO_3^- + 2\,H^+ + CO_2 + 2\,H_2O$$

Urea hydrolysis is a rapid process, which initially produces ammonium, followed by substantial increase of soil pH (reaction 1). Thereafter with nitrific tion, which is also a rapid process, extensive acidific tion is occurring (reaction 2).

This fast drop in pH is particularly the case with drip irrigation due to high application of Ultrasol™ Magnum P44 at a relatively small volume of soil below the dripper. Under such conditions the initial increase in soil solution pH is offset by the acid properties of Ultrasol™ Magnum P44 due to P-acid component. One of the main disadvantages of urea, the initial increase in pH, is thus eliminated and consequently the risk of N-volatilization is reduced.

The acidic soil environment that develops can also shift the $NH_3 + H^+ \rightleftarrows NH_4^+$ equilibrium towards NH_4^+. This will also reduce NH_3 volatilization losses.

Figure 50 shows the total NH_3 losses from three nitrogen sources applied to a mulched soil. It was concluded that Ultrasol™ Magnum P44 considerably reduced the ammonia losses compared to pure urea, while the ammonia losses with Ultrasol™ Magnum P44 were similar to ammonium nitrate.

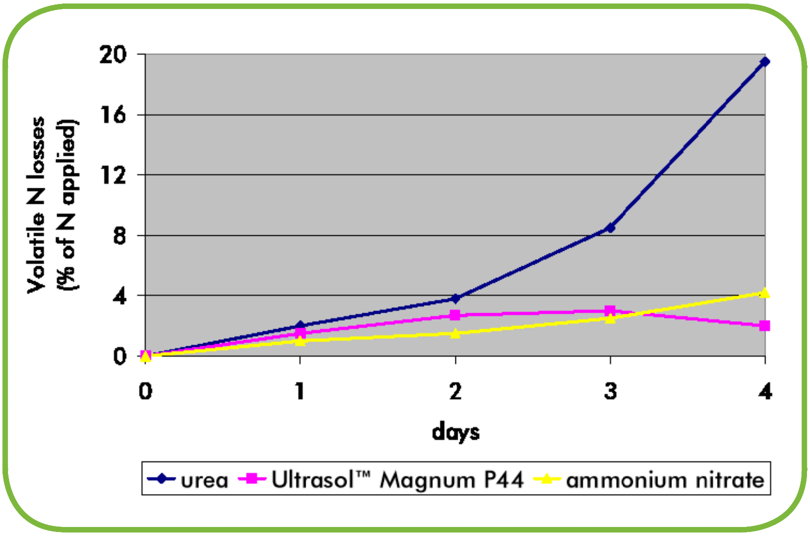


Figure 50. Total NH_3 losses from three nitrogen sources applied to a mulched soil.

Treatments

Figure 51 shows the accumulated volatilisation losses from urea, Ultrasol™ Magnum P44 and urea blended with 0,1% Ultrasol™ Magnum P44 measured over a period of 4 weeks. The fertilisers were applied to a calcareous loamy topsoil from Spain (pH 7,8). An amount of 60 mg N/pot, which is equivalent to 70 kg N/ha, was applied to the soil surface. Volatile ammonia losses were measured 3, 7, 14, 21, 28 days after fertiliser application.

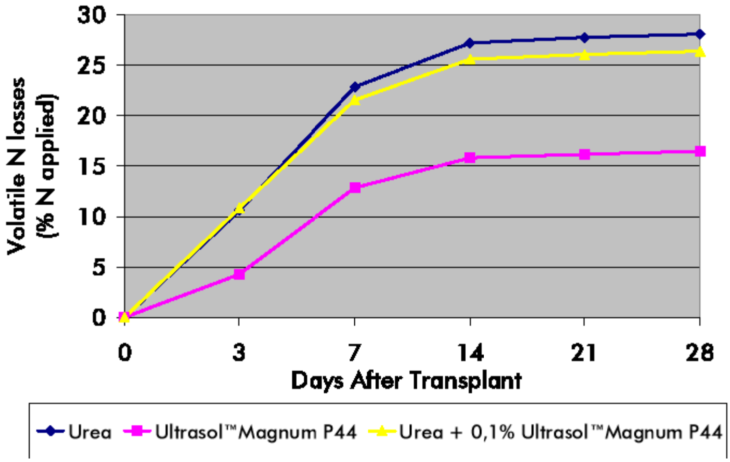


Figure 51. Volatilisation losses from urea, Ultrasol™ Magnum P44 and urea blended with 0,1% Ultrasol™ Magnum P44 applied to a calcareous loamy topsoil from Spain (pH 7,8).

Conclusions and Discussion

The lowest N-volatilization was achieved during the treatment with Ultrasol™ Magnum P44.

Addition of 0,1% Ultrasol™ Magnum P44 to urea had just a slightly decreasing effect on volatilisation losses, whereas volatilisation from Ultrasol™ Magnum P44 was reduced by 59% compared to normal urea. This is basically the result of lower losses during the firs week after application, which can be explained by the differences in the velocity of urea hydrolysis.

Lower soil pH established by Ultrasol™ Magnum P44 application is most probably the main reason for urease inhibition, which resulted in delayed urea hydrolysis and nitrific tion.

Reference

Impact of Ultrasol™ Magnum P44 on urease inhibition and volatilisation losses. 2005. Research Centre Hanninghof.

2.2.5 Fertigation with Acid NPKs Resulted in Increased Nutrient Availability in the Soil Solution

Figures 52 and 53 show the change in availability of nutrients given through fertigation with acid NPK 20-20-20 (phosphorous source from Ultrasol™ Magnum P44) compared to other products based on phosphorous source from ws-MAP. Soil analysis was performed at 20 cm and 40 cm depth. Values are expressed in relative units.

In particular the availability in the soil solution of phosphorous, calcium, magnesium, iron and zinc increased significa tly, with smaller to no effects on nitrogen, potassium, sulphur, manganese and boron.

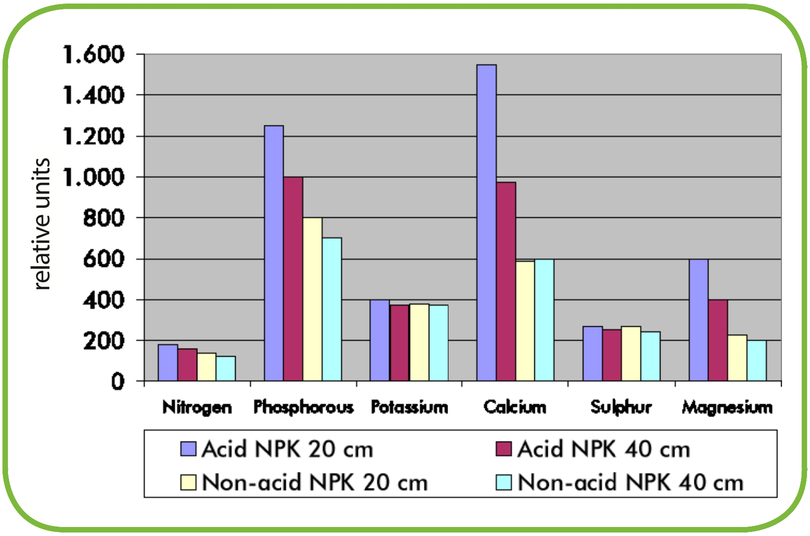


Figure 52. Availability of nutrients given through fertigation with acid NPK 20-20-20 (phosphorous source from Ultrasol™ Magnum P44) compared to other products based on phosphorous source from ws-MAP. (Soil analysis performed at 20 cm and 40 cm depth). Values are expressed in relative units.

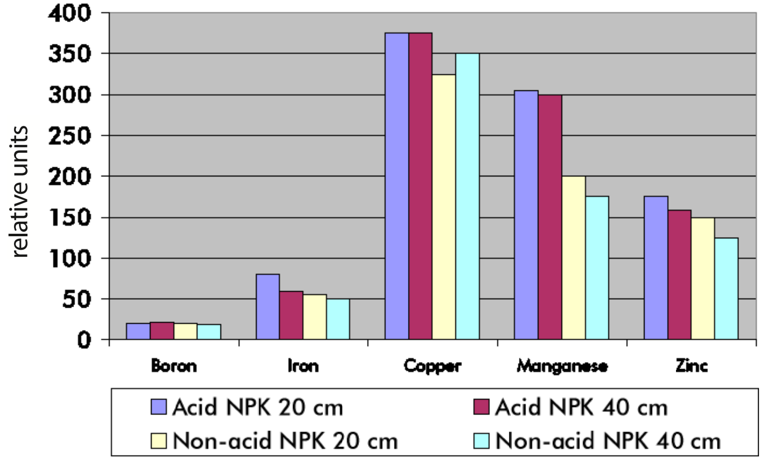


Figure 53. Availability of nutrients given through fertigation with acid NPK 20 - 20 - 20 (phosphorous source from Ultrasol™ Magnum P44) compared to other product based on phosphorous source from ws-MAP. (Soil analysis performed at 20 cm and 40 cm depth). Values are expressed in relative units.

3 Marketing & Product Management

3.1 Press Release: SQM Acquires Kemira Shares in Kefco

Kemira sells its shares in Kefco to SQM

Kemira Oyj and the other shareholders have sold their shares in Kemira Emirates Fertilisers Company (Kefco). The new owner is SQM Nitratos SA. Kefco, of which Kemira has owned 50% and which has been part of the Kemira water-soluble fertiliser business unit, is based in Dubai (United Arab Emirates). It produces, using Kemira proprietary technology, urea phosphate, which is sold throughout the world under the brand name Magnum P44 and which is used as drip irrigation fertiliser in professional vegetable and fruit cultivation. Under the terms of the agreement, SQM will also acquire the rights to the technology and the brand name. Kefco has an annual capacity of 30.000 tonnes of high quality urea phosphate. The company currently employs 28 people.

Sources:

1. http://www.kemira.com/Group/English/Media/Press+releases/2005/18072005.htm (Published 18th July 2005).
2. http://www.newaginternational.com/news/news096/news096.html (Published 19th August 2005).

Figure 54 shows the plant, located in the Jebel Ali Free Zone in Dubai, UAE. It has a capacity of 30.000 tonnes of urea phosphate per year, which will be marketed under the trade name of Ultrasol™ Magnum P44.

Figure 54. Ultrasol™ Magnum P44 plant in Dubai, UAE.

3.2 Frequently Asked Questions

3.2.1 Agronomic

What is the difference between Ultrasol™ Magnum P44 and phosphoric acid + urea?

Chemically and agronomically there is no difference, because Ultrasol™ Magnum P44 is made from phosphoric acid and urea, and in the production process no new compound is formed, the result is an adduct. This means that when dissolved into water, Ultrasol™ Magnum P44 becomes phosphoric acid and urea again. However, from the end-user's point of view there is an important difference: Ultrasol™ Magnum P44 is a powder and consequently easy to handle. It provides the same benefits and results as phosphoric acid although it looks like any powder fertiliser. Ultrasol™ Magnum P44 can also be used as a raw material in ws-NPKs.

What is the relation between Ultrasol™ Magnum P44 and phosphoric acid: how much should be applied to get the same amount of phosphoric acid?

You have to multiply the amount of Ultrasol™ Magnum P44 by 1,4 to get the corresponding quantity of phosphoric acid (H_3PO_4 85%) in the irrigation water. One should note that Ultrasol™ Magnum P44 also contains 17,5% of N, which should be taken into account when calculating the rest of the fertilisation programme.

Can Ultrasol™ Magnum P44 be applied to any crop?

Yes. The final applied solution shall however not exceed 0,2 - 0,3% in foliar application due to the risk of scorching the leaves, if no former experience exists. However, good results in foliar applications were obtained with concentrations up to 3%.

Ultrasol™ Magnum P44 contains only urea-N. Is this a restriction for some conditions or crops?

Ultrasol™ Magnum P44 is high in P (44% P_2O_5) and therefore its first function is as a P fertiliser in fertigation programmes.

If all P should be applied as Ultrasol™ Magnum P44, then only 6 - 9% of the total N requirement of the crop would be applied as urea-N. This means that the remainder of 91 - 94% of the N application can be applied with other N sources (nitrate and/or ammonium nitrogen).

The N content of 17,5% gives additionally some N, but basically Ultrasol™ Magnum P44 should always be mixed with a K source and another N source, such as Ultrasol™ K, Ultrasol™ Calcium and/or ammonium nitrate to get a balanced N, P and K mix for the crop.

This means that in the feeding solution there is also a mixture of all N forms, NO_3-N, NH_4-N and urea, which generally speaking could be the optimal N supply for the crops.

The use of Ultrasol™ Magnum P44 in rockwool or similar inert substrate is not recommended because there is no bacterial activity to decompose urea into the form which plants can utilize.

Ultrasol™ Magnum P44 contains urea. Is this generally not considered to be a less effici t N fertiliser as compared to nitrate or ammonium N?
In general this statement is true. Urea N might volatilize easily, in particular when applied on alkaline soils.

In the case of Ultrasol™ Magnum P44 this is not true. Tests have shown that volatilization losses of N applied via Ultrasol™ Magnum P44 were similar to those when N was applied with ammonium nitrate.

SQM has always promoted nitrates as a superior N source. Are we not losing credibility if we now start promoting the urea containing Ultrasol™ Magnum P44?
The answer is NO for the following two reasons:

Tests have shown that volatilization losses of N applied via Ultrasol™ Magnum P44 were similar to those when N was applied with ammonium nitrate. Therefore urea associated with phosphoric acid as in Ultrasol™ Magnum P44 acts completely different than urea alone.

If all P should be applied as Ultrasol™ Magnum P44, then only 6 - 9% of the total N requirement of the crop would be applied as urea-N. This means that the remainder of 91 - 94% of the N application can be applied with other N-sources (nitrate and/ or ammonium nitrogen). The contribution of urea N in the total N application is therefore very small.

The pH of Ultrasol™ Magnum P44 is very low. Is this detrimental to crops if a very acidic solution is applied?
The low pH of Ultrasol™ Magnum P44 is an advantage. If the soil pH is high, plant availability of many nutrients, like P, Zn, Mn, Fe and Cu is limited. Research has shown that when using Ultrasol™ Magnum P44 it is possible to lower soil pH e.g. from 8 to 7 for a certain period of time, and thus increase the plant availability of the nutrients mentioned here above.

In alkaline irrigation waters, Ultrasol™ Magnum P44 can be regarded as a water improvement additive as well, because it reduces the pH which helps to avoid formation of insoluble Mg and Ca phosphates.

In neutral and alkaline conditions there is no risk of too low pH when using Ultrasol™ Magnum P44 in fertiliser solutions, provided normal fertiliser concentrations are applied.

In which growth stages should growers apply Ultrasol™ Magnum P44?

Basically Ultrasol™ Magnum P44 can be used as the sole P source for the whole growth period and for any crop, like other P sources such as MAP, P-acid or MKP. It is mixed with other water-soluble fertiliser sources, normally with Ultrasol™ K to get K in the fertilisation programme, and in addition either with Ultrasol™ Calcium, ammonium nitrate or urea to balance the N-P-K ratio suitable to the crop requirement.

If a grower wants to use Ultrasol™ Magnum P44 only for a certain growth stage, the most beneficial timing is the beginning of the season when roots are growing most intensively. Ultrasol™ Magnum P44 is high in P which is crucial for growth of a wide and effici t root system, especially on vegetables. The high P solubility and availability of Ultrasol™ Magnum P44 gives a fast response in the initial growth of crops.

If no stock solution in used, but only the final diluted solution, then Ultrasol™ Calcium can be added at the rate of 100 g per 1,0 litre (10% solution).

Is it correct that Ca and Mg in combination with ws-MAP or MKP can easily precipitate in alkaline irrigation water? Is this also the case with Ultrasol™ Magnum P44?

Yes, this is true for MAP and MKP. Ca and Mg precipitate easily with P and make insoluble phosphates.

However, if you add suffici t Ultrasol™ Magnum P44 to this alkaline water, Ultrasol™ Magnum P44 keeps the pH down, and these insoluble phosphates are not formed.

Can we recommend Ultrasol™ Magnum P44 in inert substrates (without hardly any biological activity)?

No, because urea will not be broken down, or will transform very slowly into NH_4-N and NO_3-N.

What about Ultrasol™ Magnum P44 and EC (electrical conductivity)?

Although urea cannot be measured by EC, the product as such has an EC value of 1,22 mS/cm (1 gram per litre, 25 °C).

Will P from Ultrasol™ Magnum P44 leach out faster than P from MAP and MKP?

No. Only when the soil is P saturated there will be P leaching out.

Can Ultrasol™ Magnum P44 be used in Fe and Al rich soils?

Yes, only if pH is too low (below pH 5,5) there can be Fe and Al-phosphate formation and these phosphates are very insoluble and fi ed. However, under these acid conditions there is no need to use an acid fertiliser like Ultrasol™ Magnum P44 because there is no benefit f om its use.

Under which conditions does Ultrasol™ Magnum P44 perform the best?

When the irrigation water is hard and alkaline, and when the soil is calcareous and alkaline.

What about general P uptake efficie y in crops?

In general the P uptake efficie y is 10 - 30%, the rest remains in the soil.

3.2.2 Benefit

What makes SQM's acid Ultrasol™ Magnum NPKs containing Ultrasol™ Magnum P44 such excellent plant nutrition products?

The acidifying characteristics of Ultrasol™ Magnum P44 result in: higher P efficie y, higher micro-nutrient availability, less N volatilization losses and ease of use. Under alkaline conditions there will be no need to apply any additional liquid acids to reduce the pH of water and soil and to keep the irrigation equipment clean, since SQM's Ultrasol™ Magnum NPKs have the same benefits as Ult asol™ Magnum P44.

Do wsNPKs based on MAP and MKP have the same advantages as those wsNPKs which contain Ultrasol™ Magnum P44?

No, because MAP and MKP are already neutralized phosphoric acid compounds that do not contain any free acid, although they are slightly acidic (pH 4,5). Ultrasol™ Magnum P44 is made of H_3PO_4 which is not changed to any other chemical compound in the Ultrasol™ Magnum P44 manufacturing process, it only creates an adduct in the process, i.e. when dissolved into water, one gets H_3PO_4 and urea again. When farmers are using MAP or MKP in alkaline conditions, there is only a very small decrease in pH, because the free acid is missing. The H_3PO_4 has not only a strong pH reducing effect, but also improves the quality of water, removing bicarbonates from water and making it less hard.

What are the advantages to have urea in Ultrasol™ Magnum P44?

- Urea is an excellent foliar N fertiliser.
- Urea makes the N P solid/water soluble combination possible.
- Urea transforms in a few days to NH_4 and NO_3 in normal soil conditions. The acidity deriving from phosphoric acid limits the volatilization losses to a minimum.

What are the benefits of Ultrasol™ Magnum P44 compared to ws-MAP, ws -DAP, MKP, Phosphoric Acid?

The benefit of Ultrasol™ Magnum P44 versus MAP and MKP is that Ultrasol™ Magnum P44 contains H_3PO_4, which lowers the pH of irrigation water and soil. This in return increases efficie y of fertiliser P.

Also the availability of soil micro-nutrients, like Zn, Cu, B, Mn, Fe is increased due to a decrease in soil pH. Ultrasol™ Magnum P44 also decreases N losses of urea due to its acidity. Ultrasol™ Magnum P44 improves irrigation water quality because it removes bicarbonates which in turn prevents the formation of insoluble Ca and Mg phosphates in irrigation water.

Ultrasol™ Magnum P44 also makes some soil nutrients like Ca and Mg more soluble and more available to the plant.

MAP and MKP do not have these benefits because they do not contain any free acid; they are only slightly acidic. Phosphoric acid provides exactly the same benefit as Ultrasol™ Magnum P44, so in that respect there is no difference. However, Ultrasol™ Magnum P44 is more convenient to the grower because it comes as a powder, which is easy to handle. It also contains 17,5% N, which is lacking in phosphoric acid.

Compared to ws-MAP, ws-DAP and MKP, Ultrasol™ Magnum P44 works like phosphoric acid in keeping nozzles clean and in helping to avoid clogging.

3.2.3 Applications

Can Ultrasol™ Magnum P44 be foliar applied?

Yes, dose rates in between 0,1 - 3% have been applied, depending on the crop and moment of application. Without prior testing, concentrations higher than 0,3% are not recommended in order to avoid possible crop damage.

What are the different applications/uses of Ultrasol™ Magnum P44 besides fertigation and foliar?

Basically it should be noted that Ultrasol™ Magnum P44 is on the other hand an ordinary NP-fertiliser and can be used as an N and P source for any fertiliser application.

Soil applications were developed in France, but can be too expensive when big quantities per ha are used.

Ultrasol™ Magnum P44 has been successfully used in plant nurseries as a starter P source, applied via foliar with suffici t water to wash it into the rooting medium. Another way to promote initial growth is root dipping and root immersion.

Ultrasol™ Magnum P44 is not only used in plant nutrition, but also for cleaning purposes, like in dairies and other industries to some extent.

Ultrasol™ Magnum P44 is used as a fi e-retardant in harvested wood storages and special fi e-retardant paints and coatings.

3.2.4 General

Can Ultrasol™ Magnum P44 be declared as EC fertiliser?

Yes, it must be declared as an NP fertiliser as described on page L 304/27 of the Officia Journal of the European Union dated 21.11.2003, as published in "REGULATION (EC) Nº 2003/2003 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 October 2003, relating to fertilisers."

3.3 Product Positioning

3.3.1 Competitor Situation – Other Producers

A summary of the estimated production/sales volumes in 2006 is presented in Table 52. Kemira closed its UP plant in Finland in 2006.

Table 52. Estimated production/sales volumes in 2006.

Production area	Tonnes/year	MS (%)
SQM Dubai	15.000	48%
Competitors	16.000	52%
Total market	31.000	100%

3.3.2 Positioning of Ultrasol™ Magnum P44 - Arguments

The positioning of Ultrasol™ Magnum P44 should be as a pure, high quality SPN product, Powered by the Element Q:

1. Ultrasol™ Magnum P44 contains less insolubles than the competition, thus less risk of blocking the drip lines and nozzles.

2. Ultrasol™ Magnum P44 has a lower moisture content and consequently a lower risk of caking as compared to the competition.

3. Ultrasol™ Magnum P44 has undergone a purific tion process, which makes it a very pure plant nutrition product.

4. Constant supply, year-round, immediate availability.

5. Constant high quality.

3.3.3 Ultrasol™ Magnum P44 SWOT Analysis

Strenghts	Weaknesses
• Dry acid NP fertiliser for fertigation in alkaline soils, micro-irrigation and foliar applications. • Easy to handle compared to liquid acids. • Keep drip irrigation equipment clean and prevents clogging. • The only urea source with low risk of volatilization, similar to ammonium nitrate. • More yield - more profi .	• Price. • Urea does not mineralize in cold soils or in soilless cultures because of lack of microbial activity. • Patents limit the developments of acid wsNPKs (with Ca, with TE) in the USA, in most countries in Europe and Turkey (with Ca).
Opportunities	**Threats**
• Increase of fertigation/irrigation field . • Versatile use. • For fertigation, foliar, soil and root immersion aplications. • Stricter regulations with respect to road transport and storage of liquid acids.	• Cheap MAP. • Competition with relatively cheap products of sometimes questionable quality.

3.3.4 Sales Promotion of Ultrasol™ Magnum P44

Most sales promotion tools are avalaible in English, Spanish and Arabic:

- Ultrasol™ Magnum P44 seminar presentations.
- Leaflet .
- CD with PowerPoint presentation and promotonial tools.
- Website with downloads.
- Disk with NPK values (see Appendix 2).
- Product differentiation concepts like Ultrasol™ Magnum Flex and acid NPKs.

Ultrasol™ Magnum P44 %
Ultrasol™ K %
175
440
0
N ppm
P_2O_5 ppm
K_2O ppm
Concentration of N, P2O5 and K2O (ppm) in various mixtures of Ultrasol™ Magnum P44 and Ultrasol™ K. Total fertiliser input in solution is 1g/l (0,1%).
ppm = mg/l
Ultrasol™
Magnum P44
SQM
Ultrasol™ Magnum P44 %
N %
P_2O_5 %
pH
EC mS/cm

SQM
Ultrasol™
Magnum P 44
18-44-0
SQM
Ultrasol™
Magnum P44
18-44-0
1.000 kg

3.4 Unique Selling Propositions and Sales Arguments

Ultrasol™ Magnum P44 has a number of agronomic advantages which have been established by several research groups over the last twenty years:

Benefits/sales a guments:

- High technical performance in fertigation.
- Reduction of nitrogen volatilization.
- Anti-clogging properties, keeping irrigation systems clean and therefore keeping high performance/high distribution uniformity of irrigation systems.
- Improved nutrient uptake from the soil leading to increased efficie y.
- Leading to earliness in crop production (earlier harvests, improved crop quality).
- Control of soil salinity and alkalinity.
- Enhancement of water use efficie y.
- Applicable as a foliar fertiliser.
- Safe fertiliser for the farmer.

3.4.1 Customer Needs and Demands

3.4.1.1 Product Characteristics

- Safety.
- Nutrient content.
- Good solubility, suitability to irrigation water, pH, concentrations in use.
- Compatibility with other fertilisers.
- Reasonable price.
- Easy to use.
- Purity.
- Appearance : physical quality.

3.4.1.2 Expected Results

- Higher economical income.
- More yield.
- Environmental aspects (less P needed).
- Added values of the fertiliser.

3.4.1.3 Characteristics, Advantages and Benefit

Table 53. Overview of the main characteristics of Ultrasol™ Magnum P44 and the associated advantages and benefit .

Characteristics	Advantages	Benefits
Dry crystalline acid	Easy handing	Safe
Strong acid	Anti-clogging properties	Longer lifespan irrigation system Enables a good distribution of irrigation water and fertilisers Less work needed No additional acid needed
	Clear tank solutions	Less work needed to clean tanks
	Reduces pH of water and soil, which improves nutrient availability and nutrient uptake efficiency	Higher yield and quality, less product needed, higher cost efficiency
	Improved water infiltration and less sodium in calcareous sodic soils	Increased water use efficiency and less salt stress, resulting in higher yields
	Leading to earlier harvests (earliness)	higher income since market prices are higher in the early stage of harvesting
Double soil acidifying action	Less N volatilization under acid soil conditions	Increased nutrient and cost efficiency
Concentrated NP source	Less product needed	Efficient
Pure	No risk of clogging or growth disturbances and safe for the enviroment	Peace of mind
Highly soluble	Less water needed	Efficient
Fast dissolution	Less time needed	Efficient
Free flowing crystals	No caking	Easy handling Essential for NPK production
Urea based N source	Swells the leaf cuticula layers in foliar applications, which promotes the uptake of P and other nutrients in the spray tank mix	Efficient
Multipurpose product for fertigation, foliar sprays and NKP production	Reduced number of products needed on the farm	Efficient

3.4.1.4 Conclusions

- The best choice in alkaline-neutral soils and/or alkaline-neutral irrigation waters.
- 10 - 15% more yield when using Ultrasol™ Magnum P44 in alkaline soils compared to MAP.
- 15 - 20% more economical profit with Ult asol™ Magnum P44.

3.4.2 Sales Arguments

3.4.2.1 More Yield - More Profi

Ultrasol™ Magnum P44 is a revolutionary acidic NP fertiliser containing 17,5% of nitrogen and 44% of phosphorous.

Ultrasol™ Magnum P44 improves the growing conditions in alkaline circumstances in the root zone by lowering the pH of the water and the soil. This increases the efficie y of phosphorous and micro-nutrient uptake, helping to balance the crop's nutrition. Furthermore, plant availability of micro-nutrients such as iron (Fe), zinc (Zn) and manganese (Mn) increases as the soil pH decreases.

Trials under Mediterranean conditions have shown that vegetables can produce better fruit setting and more yield when Ultrasol™ Magnum P44 is applied as a P source, compared to other water-soluble P sources (Figure 55).

The efficie y of P was improved and with 25% less P fertilisation, a better yield up to 8 - 21% was achieved.

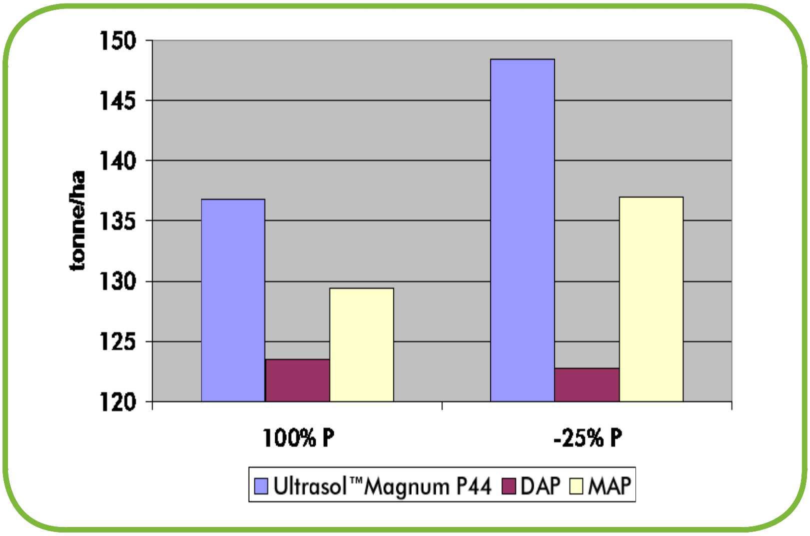


Figure 55. The effect of different P-sources and levels on eggplant yield in Cyprus.

The Ultrasol™ Magnum P44 treatments gave better fruit setting compared to the other P sources, irrespective of the P dosage. The best fruit setting and consequently the highest overall yield was achieved with Ultrasol™ Magnum P44 treatment with lower level of P. This is of crucial importance both from a farmer's and also from an environmental point of view.

The yield increase obtained by the Ultrasol™ Magnum P44 treatment was up to 8% compared to the local practice (Table 54, Figure 56). This result is most evidently due to the acidific tion effect of Ultrasol™ Magnum P44, which in turn increases P uptake by the plant and furthermore N uptake due to less losses of urea-N in alkaline conditions. Additionally, it is very likely that acidific tion of alkaline soils also increases plant availability of soil micro-nutrients.

In addition, not only the yield increased, but also the economical result could be improved.

Table 54. The effect of different P sources and levels on eggplant yield in Cyprus.

Treatments	Yield tonne/ha	Income ha (US$)	Fertiliser cost per ha (US$)	Fertiliser cost/ tonne of eggplant	Total economical result per ha		
					US$	relative	relative
MAP-1	129,4	129.400	2.002	15,5	127.398	100%	105%
DAP-1	123,5	123.500	2.104	17,0	121.396	95%	100%
Ultrasol™ Magnum P44-1	136,8	136.800	2.131	15,6	134.669	106%	111%
MAP-2	137,0	137.000	1.839	13,4	135.161	100%	112%
DAP-2	122,8	122.800	1.910	15,6	120.890	89%	100%
Ultrasol™ Magnum P44-1	148,4	148.000	1.940	13,1	146.460	108%	121%

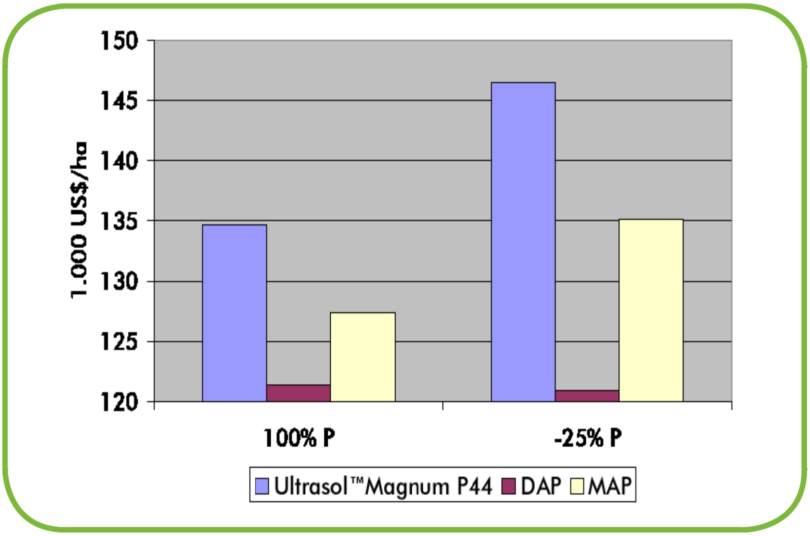


Figure 56. The effect of different P-sources and levels on farmer's income in Cyprus.

Conclusions:
The income was up to 11.299 US$ (up to 8%) with Ultrasol™ Magnum P44 compared to a MAP application in accordance with local recommendations.

These calculations can be extrapolated to other conditions by making comparisons between other local vegetables and other local fertiliser prices.

3.4.2.2 Valuable Water-Soluble Phosphorous Fertiliser Source

• Completely water-soluble:
Ultrasol™ Magnum P44 has excellent solubility, which is essential in fertigation systems. At 25 °C, solubility is 960 g/l compared to DAP at 690 g/l and MAP at 380 g/l (Figure 57).

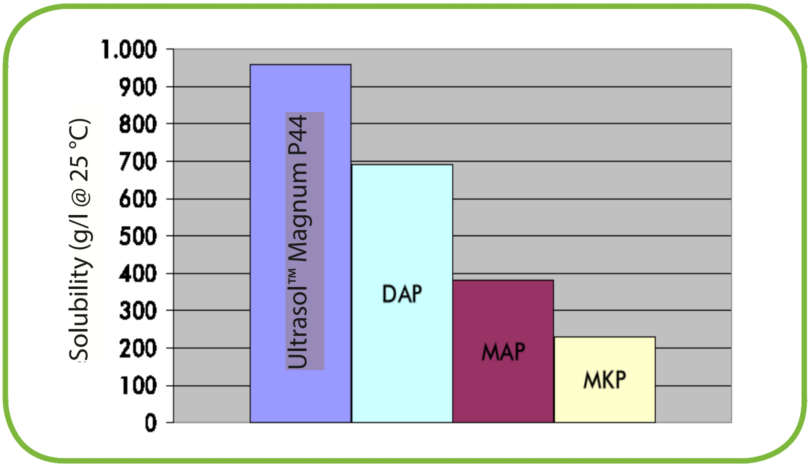


Figure 57. Solubility rate at 25 °C of various P-fertilisers.

• Phosphorous source:
The P sources differ in nutrient contents, in compatibility with other fertiliser sources, and they have different reactions in irrigation water and soil (Table 55).

Table 55. Comparison table of various fertilisers.

Product	Nutrients content	pH	Physical Form	Solubility (20 °C) g/l	Electrical Conductivity 0,1% solution (20 °C) mS/cm	Compatibility with other straights	Major advantages	Major disadvantages
UP	N 18% P_2O_5 44%	2,0	Powder	960	1,22	Good	Acid in powder form, high solubility.	Not suitable for inert substrates and hydroponics.
H_3PO_4	P_2O_5 61%	1,0	Liquid	5.480	2,15	Good	Very acidic, concentrated.	Hazardous to handle.
MAP	N 12% P_2O_5 61%	4,7	Powder	380	0,77	Good	High in P, slightly acidic.	Not ideal for alkaline conditions.
MKP	P_2O_5 52% K_2O 34%	4,5	Powder	230	0,66	Good	Very concentrated, low EC.	P-K ratio not optimal.
DAP	N 21% P_2O_5 53%	8,0	Powder	690	1,46	Difficult to use in alkaline irrigation water	Concentrated in P.	Not suitable for alkaline soils and waters, not suitable as raw material in NPKs with Mg or S.

3.4.2.3 Acid in Powder Form Is Easy to Handle and Safe to Use

Ultrasol™ Magnum P44 is a white crystalline powder. Since it is dry acid, it does not have the handling hazards of acids in liquid form.

3.4.2.4 Keeps Pipes and Nozzles of the Fertigation System Clean

Ultrasol™ Magnum P44 has the agronomic advantage of being an acidic fertiliser. This acidity prevents blockage of irrigation pipes and nozzles, which means:

- No additional acid needed for cleaning purposes, hence less work.
- The fertigation equipment lasts longer.
- Enables a good dosage of irrigation water and fertilisers.

3.4.2.5 Ultrasol™ Magnum P44 Acts as Water Quality Improvement Material by Decreasing the pH Value of Soils and Water

Ultrasol™ Magnum P44 improves the growing conditions under alkaline circumstances in the root zone by lowering the pH of the water and soil (Figures 58 and 59). This increases the efficiency of phosphorous and micro-nutrient uptake, helping to balance the crop's nutrition. Furthermore, plant availability of micronutrients such as iron (Fe), zinc (Zn) and manganese (Mn) increases as the soil pH decreases.

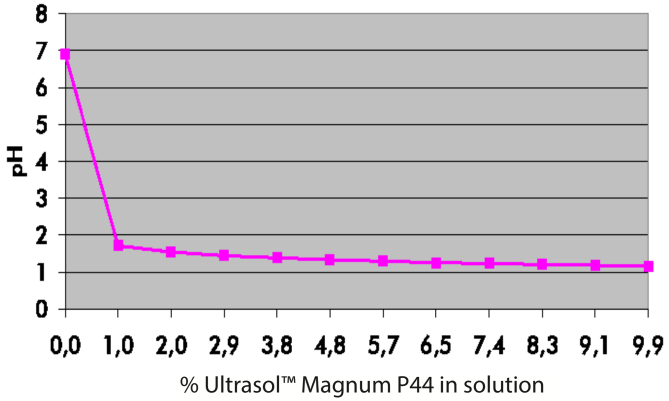


Figure 58. pH effect with Ultrasol™ Magnum P44 solution starting at pH 7.

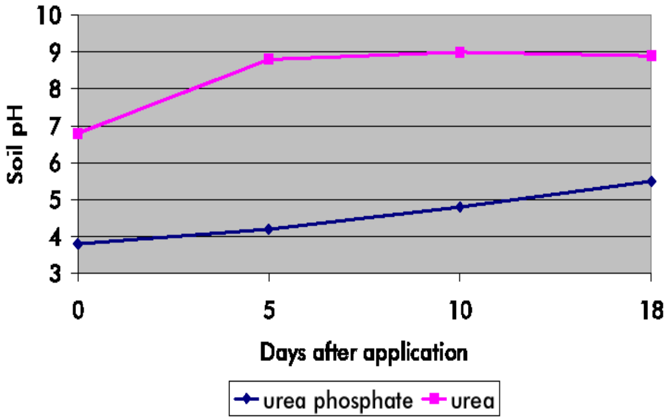


Figure 59. Soil pH following surface application of a solution of urea and urea phosphate (Bremner and Douglas, 1971).

3.4.2.6 Reduction of Nitrogen Volatilization

Research work has established that the use of Ultrasol™ Magnum P44 fertilisers reduces volatilization losses of fertiliser nitrogen (Figure 60).

This major benefit is due to the fact that the acidity of Ultrasol™ Magnum P44 deactivates soil urease enzymes and slows urea hydrolysis near the soil surface. This effect lasts a considerable time, even in highly calcareous soils, allowing the urea to be taken up by the crop.

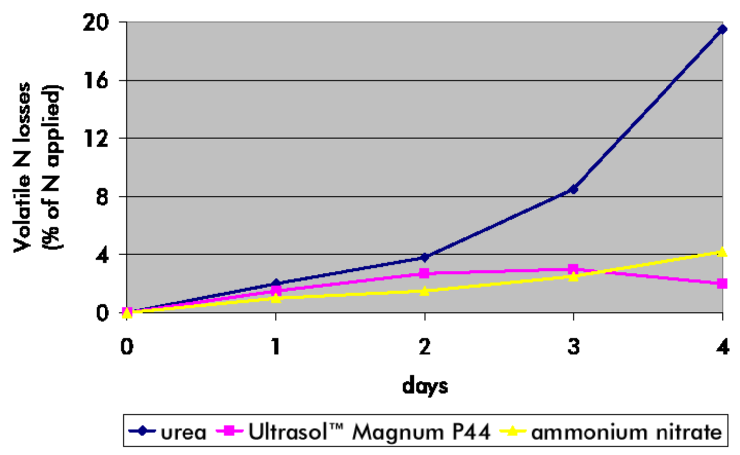


Figure 60. Total NH_3 lost from three nitrogen fertilisers applied to a mulched soil (Urban et al, 1987).

3.4.2.7 Urea Enhances P Penetration through Leaves

Table 56 shows the advantage of Ultrasol™ Magnum P44 over ordinary NPKs when both are applied via irrigation: phosphorous uptake treatment 3 (T3), which is the Ultrasol™ Magnum P44 based treatment, was significa tly higher than the other treatments at 25th May. The difference narrowed or disappeared later in the season (Figure 61).

Table 56. *Tomato leaf analysis for N, P, K, Ca, Mg and NO_3 during growing season using irrigation application of alternative fertilisers (Papadopoulos, 1992).*

Treatments	N %	P %	K %	Ca %	Mg %	NO_3-N ppm
25th May 1992						
1	2,06 ns	0,177 c	7,49 b	4,00	1,70 b	923 bc
2	1,92 ns	0,270 b	8,81 a	4,10	1,61 ab	746 c
3	2,03 ns	0,443 a	8,85 a	3,98	1,51 a	1.220 ab
4	2,00 ns	0,295 b	9,03 a	4,02	1,61 ab	1.352 a
15th July 1992						
1	1,44 a	0,117 a	4,17 a	4,16	1,78 b	1.296 a
2	1,26 b	0,098 b	2,61 b	4,58	2,11 a	713 b
3	1,41 a	0,116 a	3,55 a	4,47	1,92 ab	1.085 ab
4	1,31 b	0,109 a	3,41 a	4,29	1,76 b	862 ab

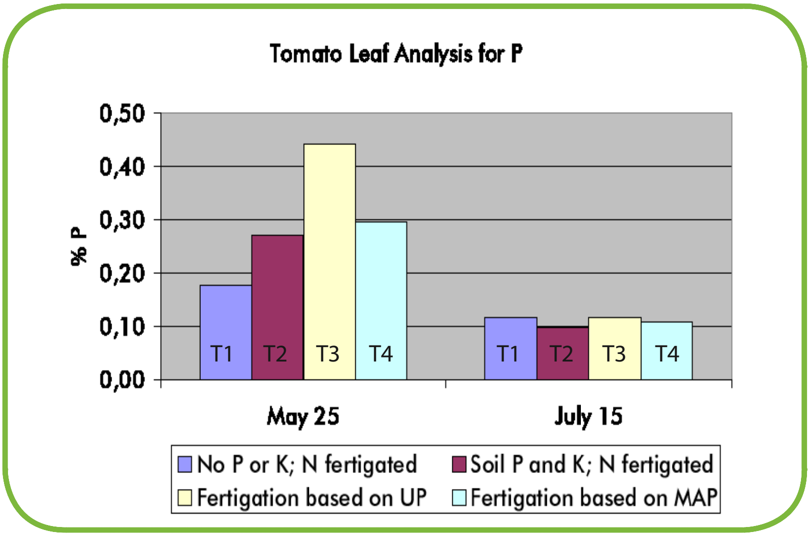


Figure 61. Effect of different fertilisation programmes on the P content of tomato leaf midribs.

3.4.2.8 Peace of Mind

- The best choice in alkaline-neutral soils and/or alkaline-neutral irrigation waters.
- 10 - 15% better yield when using Ultrasol™ Magnum P44 in alkaline soils compared to MAP.
- 15 - 20% higher economical profit when using Ultrasol™ Magnum P44 in alkaline soils compared to MAP.

3.5 Economic Calculations and Benefit

3.5.1 Example 1 of Economic Calculations and Benefit

It should be noted that this is an example and that these calculations can be applied to other conditions by making comparisons between other local vegetables and other local fertiliser prices (Table 57).

Details on this trial can be found in module 2 (trials), part 2.1 (fertigation trials): Cyprus - Eggplant.

1. Average prices for fertilisers

Table 57. Average prices for fertilisers and nutrient contents of fertilisers (2000).

Average prices for fertilisers			Nutrient content		
	US$	€	N	P_2O_5	K_2O
Ultrasol™ Magnum P44	445	506	18	44	
MAP	440	500	12	61	
DAP	490	557	20,5	53	
AN	150	170	34,5		
NOP	340	386	13,5		46
SOP	220	250			50
MKP	650	739		51	35
CAN	220	250	27		
exchange rate 1 € = 0,88 US$					

2. End product prices

Table 58 describes the trial set up with three P treatments, carried out at two different P levels. The fertigation solution and water use per treatment is shown in Table 59. The average price for eggplants in Cyprus was 1.000 US$/tonne.

Table 58. Trial set up with three P treatments, carried out at two different P levels.

Trial	Fertiliser	Total kg	N kg/ha	P_2O_5 kg/ha	K_2O kg/ha	Cost US$	Cost €
1A	MAP	1.388	167	846		611	694
	Ultrasol™ K	3.840	518		1.766	1.306	1.484
	AN	575	198			86	98
	Total	**5.803**	**883**	**846**	**1.766**	**2.003**	**2.276**
1B	MAP	965	116	589		425	483
	Ultrasol™ K	3.840	518		1.766	1.306	1.484
	AN	722	249			108	123
	Total	**5.527**	**883**	**589**	**1.766**	**1.839**	**2.090**
2A	DAP	1.597	327	846		783	889
	Ultrasol™ K	3.840	518		1.766	1.306	1.484
	AN	108	37			16	18
	Total	**5.545**	**883**	**846**	**1.766**	**2.105**	**2.391**
2B	DAP	1.111	228	589		544	619
	Ultrasol™ K	3.840	518		1.766	1.306	1.484
	AN	397	137			60	68
	Total	**5.348**	**883**	**589**	**1.766**	**1.910**	**2.171**
3A	Ultrasol™ Magnum P44	1.924	394	846		856	973
	Ultrasol™ K	3.621	489		1.666	1.231	1.399
	AN	0	0			0	0
	SOP (ws)	201			101	44	50
	Total	**5.746**	**883**	**846**	**1.766**	**2.131**	**2.422**
3B	Ultrasol™ Magnum P44	1.338	274	589		595	677
	Ultrasol™ K	3.840	518		1766	1.306	1.484
	AN	262	91			39	45
	Total	**5.440**	**883**	**589**	**1.766**	**1.940**	**2.206**

Table 59. Fertigation solution and water use per treatment.

Treatments	N mg/l	P_2O_5 mg/l	K_2O mg/l	Water usage (in fertigation)
A (100% of P recommended)	120	115	240	7.360 m^3/ha
B (70% of P recommended)	120	80	240	7.360 m^3/ha

Table 60. Yield, income and cost:benefit omparison between three P treatments, carried out at two different P levels.

Treatments	Yield tonne/ha	Income ha (US$)	Fertiliser cost per ha (US$)	Fertiliser cost/ tonne of eggplant	Total economical result per ha US$	relative	relative
MAP-1	129,4	129.400	2.002	15,5	127.398	100%	105%
DAP-1	123,5	123.500	2.104	17,0	121.396	95%	100%
Ultrasol™ Magnum P44-1	136,8	136.800	2.131	15,6	134.669	106%	111%
MAP-2	137,0	137.000	1.839	13,4	135.161	100%	112%
DAP-2	122,8	122.800	1.910	15,6	120.890	89%	100%
Ultrasol™ Magnum P44-1	148,4	148.000	1.940	13,1	146.460	108%	121%

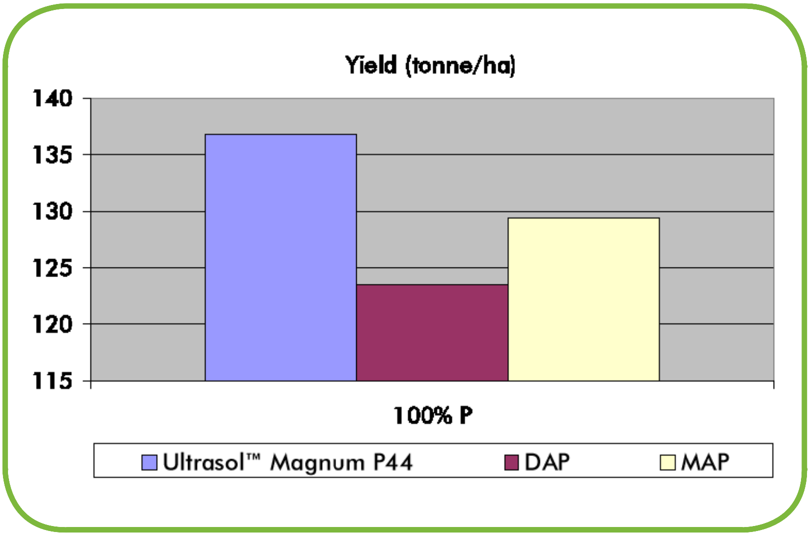


Figure 62. Yield comparison between three P treatments, carried out at the standard (100%) P level.

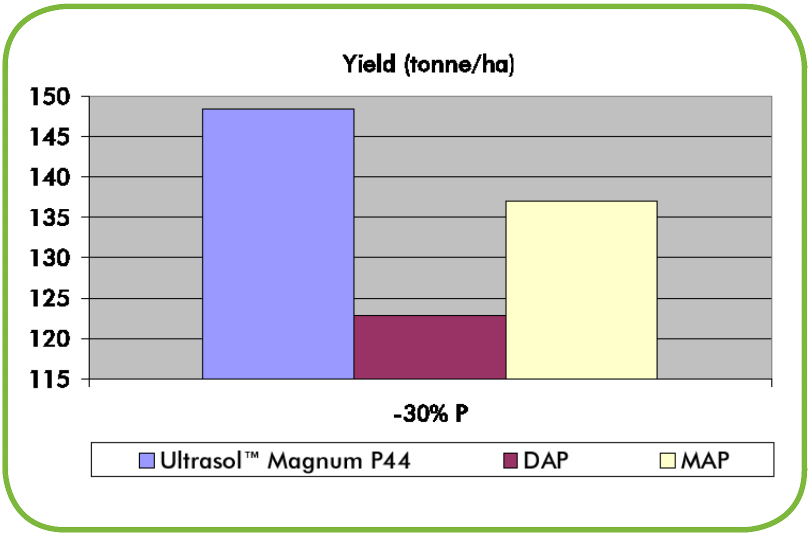


Figure 63. Yield comparison between three P treatments, carried out at the lower (70%) P level.

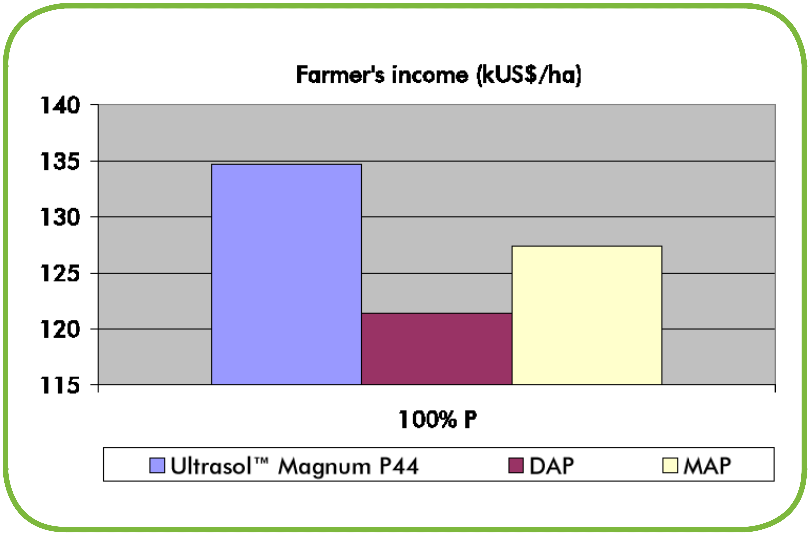


Figure 64. Net income comparison between three P treatments, carried out at the standard (100%) P level.

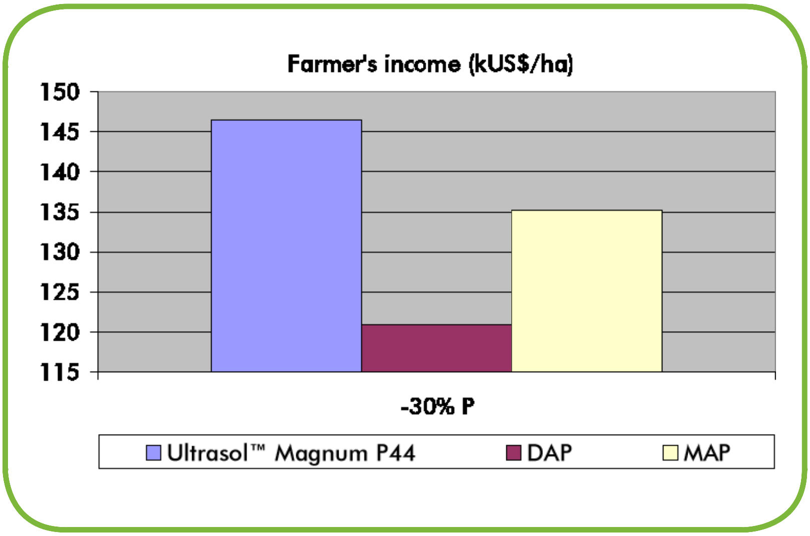


Figure 65. Net income comparison between three P treatments, carried out at the lower (70%) P level.

When taking into consideration average prices for the fertilisers and for eggplant, it can be concluded that even if the total fertiliser costs of UltrasolTM Magnum P44 per ha (2.131 USD) are slightly higher compared to MAP (2.002 USD) and DAP (2.104 USD), the fertiliser costs of UltrasolTM Magnum P44 per tonne of yield is almost the same for UltrasolTM Magnum P44 (15,6 USD) and for MAP (15,5 USD) and lower than for DAP (17 USD), thanks to the increased yield obtained with UltrasolTM Magnum P44 (Table 57, Figures 62-65).

The yield increase obtained by the UltrasolTM Magnum P44 treatment was up to 8% higher compared to the local practise (MAP) and up to 21% higher as compared to DAP.

This had of course an important impact on the economical income. The income was up to 11.299 US$ (up to 8%) with UltrasolTM Magnum P44 compared to a MAP application in accordance with local recommendations.

It should be noted that this is an example and that these calculations can be extrapolated to other conditions by making comparisons between other local vegetables and other local fertiliser prices.

3.5.2 Example 2 of Economic Calculations and Benefit

Table 61 summarizes the economic results of our trials. The following two examples will help to explain how this table should be read.

Observe the first trial "eggplant Cyprus". If SQM wants to share the net added value of UltrasolTM Magnum P44 over MAP for 50% with the farmer, then the price of UltrasolTM Magnum P44 could be 39.058 €/tonne.

Observe as a second example "potato UK 2001". If SQM wants to take only 20% of the net added value of UltrasolTM Magnum P44 over MAP, thus leaving 80% for the farmer, then the price of UltrasolTM Magnum P44 could be 1.246 €/tonne, against a MAP price of 720 €/tonne.

For simulation purposes it was assumed that farmer prices for UltrasolTM Magnum P44 and MAP were identically set at 1.000 € per 1.000 kg, since in most trials prices for the fertilisers were not mentioned.

It can be concluded that if 1 tonne MAP values 1.000€/tonne, the UltrasolTM Magnum P44 can cost 2.894-77.182 €/tonne in order to get an identical net income for the farmer. So, speaking from an agronomical point of view, UltrasolTM Magnum P44 can be sold at at least 2,9 times the price of MAP. This analysis excludes competitor behaviour.

Table 61. Overview of the economic results of the trials and potential price simulation for Ultrasol™ Magnum P44 compared to MAP.

Crop and country	Product	Dose	Dose	Price	Cost	Difference in net profit	Theoretical price Ultrasol™Magnum P44 when x% of the net profit is shared with the grower		
		P_2O_5 kg/ha	product kg/ha	product €/1.000 kg	product €/ha	UM P44 minus MAP €/ha	x=0% €/MT	x=50% €/MT	x=80% €/MT
Eggplant Cyprus	UM P44	88	200	1.000	200	15.250	77.182	39.058	16.184
	MAP	114	187	1.000	187				
Tomato Cyprus	UM P44	160	364	1.000	364	4.500	13.349	7.161	3.449
	MAP	216	354	1.000	354				
Melon Spain	UM P44	100	227	1.000	227	810	4.285	2.503	1.434
	MAP	100	164	1.000	164				
Watermelon Greece	UM P44	110	250	1.000	250	1.300	5.921	3.321	1.761
	MAP	110	180	1.000	180				
Potato Cyprus	UM P44	247	561	1.000	561	1.200	2.894	1.825	1.184
	MAP	259	425	1.000	425				
Potato UK 2001	UM P44	80	182	1.120	204	661	4.155	2.337	1.246
	MAP	80	131	720	94				
Potato UK 2002	UM P44	90	205	1.120	229	423	2.587	1.553	933
	MAP	90	148	720	106				
Soybean Foliar	UM P44	3	6	1.000	6	90	15.000	7.500	3.000

Assumed that price tomato = 0,50 € per kg.
Assumed that price potato = 0,10 € per kg.
1 € = 1,25 US $

4 Literature

4.1 Ultrasol™ Magnum P44 as a Fertiliser

4.1.1 Doubled Annual Production for Protected Table Grape Viticulture in Sicily

OT: La doppia produzione annuale nella viticoltura da tavola protetta in Sicilia.
AU: Lorenzo,-R-di; Barbagallo,-M-G; Gambino,-C; Pasquale,-F-de
SO: Rivista-di-Frutticoltura-e-di-Ortoflo icoltura. 2006; 68(2): 24-28
PB: Bologna, Italy: Il Sole 24 Ore Edagricole Srl.
PY: 2006
LA: Italian

AB: Following a consideration of table grape production in tropical and subtropical environments, this paper presents the results of studies undertaken in 2005 by the University of Palermo's Department of Tree Crops of grape vines grown under cover in the Mazzarrone IGP (Indication of Geographic Provenance) area of SE Sicily to investigate the possibility of obtaining 2 growth cycles, and hence to double the production in one year. Eighteen-year-old vines of cv. Matilde grafted on 1103 Paulsen rootstocks, planted at a spacing of 3 x 3 m, were grown in a 2,8 m high hut-like structure, covered in plastic film. The first early yield was obtained at the end of May-beginning of June. After harvesting in the second week of June, the greenhouse was opened. Vines were pruned at the beginning of July to stimulate the second yield cycle. The study involved 120 uniform plants, trained to the Guyot system, and treated with 2 or 4% Dormex (hydrogen cyanamide) fi e days after pruning to promote bud burst, with or without urea phosphate foliar feed. The greenhouses were again covered in September. Second harvest was at the end of October. The results showed that the first production cycle lasted 157 days and was characterized by phenological phases longer than normal. The second production cycle lasted 99 days and was characterized by shorter than normal phenological phases, particularly with regard to the "bud burst to fruit setting" stage. The percentage of blind buds ranged from 80,7% in the untreated control to 37,3% in vines treated with 4% Dormex. Average first yields were 18 kg/plant

(20 t/ha). Average second yields were 7 kg/plant (excluding the control, which produced only 3,9 kg/plant), although treatment with 2% and 4% Dormex gave second yields of 7,8 and 9,9 kg/plant, respectively. Quality characteristics of bunches from the second yield were satisfactory. The results demonstrated that it is possible to increase annual yields from 20 t/ha to around 30 t/ha with a second cycle, but only with hydrogen cyanamide treatment at the start of the second production cycle.
PT: Journal-article
IS: 0392-954X
AN: 20063031032

4.1.2 Use of Sulphur Coated Urea, Ammonium Sulphate and Urea Phosphate on Blueberries in Florida for N and pH Control

AU: Crocker,-T-E
SO: Proceedings-of-the-Florida-State-Horticultural-Society. 1983 publ 1984; 96: 226-227
PY: 1983; publ. 1984
LA: English
AB: In trials at 2 localities with rabbit eye blueberry (Vaccinium ashei) cultivars Tifblue and Delite, sulphur-coated urea, urea phosphate or ammonium sulphate were applied at 30 or 45 lb N/acre. A suitable soil pH (<5) could be maintained by each of these N sources even when water with a high pH (7,6-7,7) was used for irrigation. Since foliar N levels at both fertiliser application rates were below the recommended range (1,5-1,7%), it is advised that more than 45 lb N/acre are to be applied.
PT: Journal-article
IS: 0886-7283
AN: 19850331623

4.1.3 Prolonging the Harvesting Season of Minneola Tangelo Fruits by Spraying with Nutrients and Growth Substances

AU: Lavon,-R; Bar-Akiva,-A; Shapchisky,-S; Cohen,-E; Shalon,-Y; Brosh,-P
SO: Hassadeh-. 1982; 63(3): 492-497
PY: 1982
LA: Hebrew
LS: English
AB: Tangelo trees (cv. Minneola) were sprayed with a mixture of 1% urea phosphate and GA (10 or 20 ppm) or GA alone. Spraying delayed fruit maturation and senescence, and fruits also showed improved elasticity, lower ethanol contents and respiration rates, fewer skin blemishes and less decay. The mixture was more effective in prolonging harvesting and increasing shelf life than GA or urea phosphate used separately.
PT: Journal-article
IS: 0017-8314
AN: 19830314514

4.1.4 The Effect of Nutritional Treatments on Post Harvest Quality and Flavour of Valencia Oranges

AU: Baldry,-J; Dougan,-J; Howard,-G-E; Bar-Akiva,-A
SO: Journal-of-Horticultural-Science. 1982; 57(2): 239-242
PY: 1982
LA: English
AB: Samples of fruit from Valencia orange trees treated with either urea phosphate or potassium nitrate foliar sprays or with soil-applied potassium sulphate, were examined after standard commercial shipment and handling. In acceptability trials, fruit from urea phosphate-treated trees had the highest ratings for freedom from skin blemishes, sweetness, a pleasant degree of acidity and fruit fl vour; soil-applied potassium was associated with a tendency to tartness.
PT: Journal-article
IS: 0022-1589
AN: 19820307320

4.1.5 Rapid Evaluation of Foliar Fertiliser-Induced Damage: N, P, K, S on Corn

AU: Neumann,-P-M
SO: Agronomy-Journal. 1979; 71(4): 598-602
PY: 1979
LA: English
AB: In a laboratory experiment, 0,3 cm wide segments of maize leaves were infilt ated under reduced pressure with various solutions containing 1 of 9 fertilisers, and damage was assayed by optical density measurements of UV-absorbing solutes leaking from cells. Damaging concentrations of N ranged from 3,5 to 31 g/l, with urea markedly being the least damaging N source, and those of P, K and S sources were in the ranges 3,8-11, 12,2-22 and 6,4-8,2 g/l, respectively. Urea phosphate was the most damaging of the P sources and ammonium polyphosphate, potassium polyphosphate and K_2SO_4 were the least damaging sources of P, K and S, respectively. In a field trial, urea and urea phosphate caused leaf burn at more than or equal to 60 g/l and more than or equal to 40 g/l, respectively, compared with 66 g/l and 19 g/l in the laboratory. Leaf cell membrane damage was not consistently related to solution pH, molarity, conductivity or osmotic pressure.
PT: Journal-article
IS: 0002-1962
AN: 19790701266

4.1.6 Reactions of Urea Phosphate in Calcareous and Alkaline Soils: Ammonia Volatilization and Effects on Soil Sodium and Salinity

AU: Ali-AMS
SO: 1989, 88 pp.; 54 ref.
PB: University Microfilms nternational; Ann Arbor, MI; USA
LA: English
AB: A study was made to determine the effectiveness of urea phosphate (UP) in reducing soil alkalinity and loss of NH_3 when ammonium forming fertilisers are applied to alkaline soils. The volatilization of NH_3 from UP and urea (U) was studied on 3 selected soils (Hayhook SL, Laveen L and Latene L) using an aeration system. Urea phosphate and urea were each applied at rates of 0, 50, 100 and 200 ppm-N either to the surface, dry or in solution or mixed with the soil. The volatilized NH_3 was trapped in sulphuric acid, sampled periodically and analyzed for N using the semi micro-Kjeldahl distillation apparatus. The effect of UP, sulphur-foam (SF), phosphoric solution (PHP, a mixture of urea, phosphoric acid and sulphuric acid) and a mixture

of SF and UP on leaching soil sodium and salinity was also studied in two soils (Pima L and Crot CL) in columns. Each of these amendments was applied at a rate of one and two equivalent amounts of the exchangeable sodium (Na-ex).

The highest loss of N in the form of NH_3 occurred when urea was applied to Hayhook soil. However, UP applied to Hayhook soil (neutral to acidic, coarse textured and low $CaCO_3$ content) resulted in the lowest loss of NH_3-N. Less loss of NH_3-N was found from U application to Laveen and Latene soils (fine textured with higher $CaCO_3$ content) than with Hayhook soil. The general trend was higher loss of N, in the form of volatilized NH_3, with surface application dry or in solution than when mixed with the soil. This trend showed an increase in the amount of volatilized NH_3 with increasing rate of N-application. Urea phosphate was as effective as PHP or a UP-SF mixture (acid containing fertilisers) treatments in reducing soil salinity and alkalinity in Pima and Crot soils. No difference was found between rates of application (1 and 2 equivalent amounts of Na-ex) except for soil pH. A similar trend in the decrease in soil salinity was found to that of the pH which was in the order PHP, UP, UP-SF mix, SF and control treatments. No significa t difference was found between SF and control treatments in all parameters. No signifi ant difference was found between treatments for exchangeable Ca. This was affected by the Ca compounds present in the soil. UP is a potential fertiliser for supplying N and phosphorous (P) as plant nutrients, reducing NH_3 volatilization, and can be used as a soil amendment to control soil salinity and alkalinity.
PT: Miscellaneous
AN: 901949122

4.1.7 Urea Phosphate Effects on Infilt ation and Sodium Parameters of a Calcareous Sodic Soil

AU: Ryan-J;Tabbara-H
SO: Soil-Science-Society-of-America-Journal. 1989, 53: 5, 1531-1536.
LA: English
AB: In a laboratory study, urea phosphate (0-20 g/kg solutions) containing H_3PO_4 was evaluated with respect to initial infilt ation of the urea phosphate (UP) solution and subsequent infilt ation with water alone. A calcareous clay soil was equilibrated in columns with saline solutions (EC 1,5 dS/m) with sodium adsorption ratios (SAR) of 5, 10, 20, 40 and 60, to give varying exchangeable sodium percentages (ESP). Initial Infilt ation Rates (IR) were enhanced only with the dilute UP solutions, i.e. 1,0 and 2,5 g/kg, while all UP solutions improved subsequent infilt ation with water alone. As the UP concentration of the infilt ating solution increased, decreases occurred in soluble Na from the saturation extract and exchangeable Na, and estimated SAR. The improvement in IR was probably due to H_3PO_4 solubilizing $CaCO_3$ for exchange

reactions of Ca^{2+} with soil Na+. Urea phosphate may therefore enhance water use efficie y in some irrigated soils as well as serving as an effective source of N and P.
PT: Journal-article
AN: 901941345

4.1.8 Application of Urea Phosphate and Urea Sulphate to Drip-Irrigated Tomatoes Grown in Calcareous Soil

AU: Mikkelsen-RL; Jarrell-WM
SO: Soil-Science-Society-of-America-Journal. 1987, 51: 2, 464-468; 1 fi ., 7 tab.; 30 ref.
LA: English
AB: The potential benefit of acid applied through drip irrigation on soil nutrient availability, plant nutrition, and yield was studied. Tomatoes (Lycopersicon esculentum cv. Better Boy) were grown in a P deficie t calcareous loam in plastic-lined cans. Phosphorous was added weekly through drip irrigation as urea phosphate (UP) (17-19-0) at four concentrations (0, 20, 40, 80 kg P per ha). Two other treatments entailed 40 kg P per ha soil-banded triple super phosphate (TSP) (0-20-0) with or without the addition of drip-applied urea sulphate (US) (15-0-0-16). Urea sulphate was added at the rate equivalent to the titratable acidity of the 40 kg UP-P ha-1 treatment. Urea was added to all treatments to provide the equivalent of 100 kg N per ha. The plants were grown for 73 days after transplanting prior to harvesting, weighing, and analysis. Soil samples were taken in 5-cm depth increments at 0-, 10-, and 20-cm distances from the emitter and analyzed for pH, P, Fe, Mn, and Zn. Yields of fruit and vegetative matter were higher in the 20 kg UP-P per ha treatment than in any other treatment. Phosphorous moved in the soil to a depth of 30 cm at the 80 kg UP-P per ha application rate. Leaf Zn concentration decreased with increasing rates of P fertilisation. Application of acid solubilized native soil P, Fe, and Mn, resulting in highest tissue concentrations of Fe and Mn in the plants receiving US. Urea sulphate was more effective in soil acidific tion and Fe and Mn solubilization than the equivalent titratable acidity derived from UP. Urea sulphate can be beneficial where Fe and Mn deficiencies occur. Urea phosphate appears to be an effective P fertiliser for application through drip irrigation systems.
PT: Journal-article
AN: 871916134

4.1.9 Using Urea Phosphate to Enhance the Effect of Gibberellin GA3 on Grape Size

AU: Shulman-Y; Fanberstein-L; Bazak-H
SO: Plant-Growth-Regulation. 1987, 5: 3, 229-234; 11 ref.
LA: English
AB: GA3 is widely used after fruit set to enlarge the berries of seedless grapes. In cv. Sultana (Thompson Seedless) the addition of 1.000 mg per litre urea phosphate (UP) to GA3 solutions (which reduced the pH of the solutions to a stable pH 2,9) enhanced the effect of GA3 on berry size and delayed maturation. Addition of citrate buffer, pH 2,9, to GA3 sprays did not affect berry size or maturation. The possibility of improved GA penetration due to the low pH is considered. The nutritional effect of UP (as a source of N and P) and the possibility of enhanced membrane permeability induced by the urea ion are also discussed.
PT: Journal-article
AN: 870346967

4.1.10 Phosphorous Fertiliser Carriers and Their Placement for Minimum Till Corn Under Sprinkler Irrigation

AU: Raun-WR; Sander-DH; Olson-RA
SO: Soil-Science-Society-of-America-Journal. 1987, 51: 4, 1055-1062; 1 fi ., 7 tab.; 31 ref.
LA: English
AB: Several methods of placement and sources of P were evaluated for sprinkler irrigation corn (Zea mays L.) grown under minimum tillage on a Sharpsburg silty clay loam (Typic Argiudoll) and a Coly silt loam (Typic Ustorthent). Nitrogen and P, dual placed in a localized band (anhydrous ammonia applied with liquid P sources), accomplished greater P uptake and higher corn grain yields on a P deficie t calcareous soil than P banded to the side of the seed or banded below the seed, although both methods increased early plant growth compared to either broadcast or P dual placed with NH_3. Broadcast pre-plant applications of P were equally as effective as dual placed P in this study. Explanation of yield and P uptake enhancement by dual placement may lie in the synergistic effect of ammoniacal N and P placed together. The superior performance of the broadcast method of P application was apparently due to root activity near the surface of the soil or in the soil residue interface. In contrast, starter band applications gave higher yields than broadcast or dual placed methods of P application on these two soils, low subsoil P levels in the calcareous soil compared to the acid soil was believed to be a contributing factor. Enhanced early P uptake with such row applications may increase yields where high subsurface P levels exist. Urea phosphate (UP) provided greater yields, grain P uptake, and total

P uptake than ammonium polyphosphate (APP) and diammonium phosphate (DAP) at the calcareous site, especially when band (side), broadcast, and dual placement methods of P application were used. Total P concentration from plant tissue taken at the eight-leaf stage was greater for UP than APP and DAP on the slightly acid soil, but no yield differences could be attributed to sources at the site.
PT: Journal-article
AN: 881919954

4.1.11 Ammonia Volatilization from Urea Phosphate Fertilisers

AU: Mikkelsen-RL; Bock-BR
SO: In Ammonia volatilization from urea Fertilisers. TVA-Bulletin,-Tennessee-Valley-Authority.1988,Y-206, 175-189; 4 fi ., 5 tab.; 49 ref.
LA: English
AB: Urea phosphate (UP), the addition product of urea and H_3PO_4, is a potentially useful fertiliser in supplying N and P to plants. Acidity derived from the H_3PO_4 may inactivate soil urease and slow urea hydrolysis. The acidic soil environment that develops surrounding the fertiliser granule can also shift the $NH_3 + H^+ <-> NH_4^+$ equilibrium towards NH_4+. Both factors can reduce NH_3 losses. Direct measurements of NH_3 volatilization conducted in the laboratory and field indicate that NH_3 losses may be greatly reduced through use of UP compared with urea alone. However, UP is less effective in reducing NH_3 loss in calcareous soils.

Indirect estimates of NH_3 loss have been made through comparisons between yield and mineral composition of UP- and urea-fertilised plants. Such evaluations commonly show that UP is superior to urea as a surface-applied N fertiliser, partly because it reduces NH_3 volatilization losses.
PT: Book-chapter; Journal-article
IB: 0-87077-003-9

4.1.12 Solubility and Availability of Urea Phosphate as Phosphate Fertiliser in an Alluvial Soil of Egypt

AU: Mashali-SA

SO: Egyptian-Journal-of-Soil-Science. 1995, 35: 3, 325-336; 16 ref.

LA: English

LS: Arabic

AB: The potential benefit of urea phosphate (UP) as a P fertiliser in comparison with monocalciumphosphate (MCP) and diammonium phosphate (DAP), with and without urea (U), was studied using alluvial clay soil from the Nile Delta, Egypt. Solubility changes of UP (MCP; DAP; MCP + U and DAP + U) were investigated through 3 and 10 wetting/drying cycles using two rates of P additions. Treatments enhanced soluble-P in the order UP > MCP > MCP + U > DAP > DAP + U after both 3 and 10 wetting/drying cycles and low and high rates of P application. Percentages of P recovery from UP treatments, after 3 cycles of wetting/drying and for low and high P rates, decreased in the above order, being three times that from other treatments. Solubility equilibriums calculation for low and high P rates after 3 and 10 wetting/drying cycles were plotted on solubility diagrams. Lime potential tended to be lower and phosphate potential tended to be higher with UP treatments as compared to other treatments. Addition of different P materials increased plant DM of barley, hybrid 89 and P uptake more from UP than other P fertilisers. Phosphorous concentration in the plant tissue was increased in the order UP > DAP > MCP > DAT + U MCP + U > control.

PT: Journal-article

AN: 961904794

4.1.13 Effect of Applying Soluble and Coated Phosphate Fertilisers on Phosphate

AU: Garcia-MC; Diez-JA; Vallejo-A; Garcia-L; Cartagena-MC

SO: Journal-of-Agricultural-and-Food-Chemistry. 1997, 45: 5, 1931-1936; 19 ref.

LA: English

AB: The effect of phosphorous fertilisers on phosphate availability in calcareous soils with a high phosphorous fix tion capacity was studied. Tests were run with urea phosphate, triple super phosphate, simple super phosphate, and diammonium phosphate, and controlled-release fertilisers (lignin-coated triple super phosphate and rosin-coated diammonium phosphate), each providing phosphate to the soil at a different rate. Simultaneous experiments were run (in calcareous soils) with a plant (glasshouse test) and with no plant (incubation test). Phosphate availability and, therefore, plant phosphorous absorption increased in those soils where fertilisation

was done with urea phosphate or with lignin-coated triple super phosphate. Other fertilisers such as uncoated super phosphates or diammonium phosphate did not significa tly increase P availability compared to the unfertilised soil. The electro-ultrafilt ation technique was also used for predicting the amount of P absorbed by a crop in calcareous soils after applying a phosphate fertiliser.
PT: Journal-article
AN: 981903098

4.1.14 Ammonia Volatilization from Ammonium Nitrate, Urea and Urea Phosphate Fertilisers Applied to Alkaline Soils

AU: Yerokun-OA
SO: South-African-Journal-of-Plant-and-Soil. 1997, 14: 2, 67-70; 30 ref.
LA: English
AB: The volatilization of ammonia following applications of urea fertilisers to soils may release significa t amounts of N into the atmosphere and reduce the plant available N. This study compared ammonia loss from urea phosphate (170 g N/kg, 190 g P/kg), cogranulated urea-urea phosphate (340 g N/kg, 73 g P/kg), urea (460 g N/kg) and ammonium nitrate (350 g N/kg) granular fertilisers applied to the soil surface at 60, 120 and 200 mg N/kg soil. Soil moisture contents were adjusted to 100% and 25% of field moisture capacity at the beginning of the experiment. Ammonia losses from cogranulated urea-urea phosphate and urea were similar, being as much as 7,8% of applied nitrogen in 14 days. Urea phosphate and ammonium nitrate exhibited significa tly lower ammonia losses. As the amount of applied N increased, corresponding ammonia loss increased. An initial soil moisture at 25% field moisture capacity caused the fertilisers to lose more ammonia than when the soils were initially at 100% field moisture capacity. The data suggest that urea phosphate has a lower ammonia volatilization potential than urea, but increasing the urea to phosphoric acid mole ratio to achieve a higher N analysis (cogranulated urea-urea phosphate) suppresses the effect of phosphoric acid and raises the ammonia volatilization potential.
PT: Journal-article
AN: 981900364

4.1.15 Utilization of 15N to Evaluate the Availability of Nitrogen from Different Fertilisers for Lolium Multifloru

AU: Calancea-L; Bologa-M; Chiriac-M

SO: Studia-Universitatis-Babes-Bolyai,-Biologia. 1990, 35: 1, 37-44; 10 ref.

LA: English

AB: Pot experiments were carried out on herbage yield of Lolium multifloru grown at 200 mg seeds/pot and cut 3 times. Each pot, filled with 3 kg of pseudogleyic podzolized soil containing 100 mg P_2O_5, was supplemented with 0, 50, 100, 200, 300, 400 and 500 mg N applied as urea, urea phosphate, urea formiate, isobutylidene diurea (IBDU), phosphoryl triamide and phosphonitrilic hexamide. All N fertilisers were labelled with 15N to determine the plant N content derived from the fertilisers compared with N derived from soil reserves.

The yield effects of the 6 fertiliser types were analyzed for the 1st and 2nd cuts. Without N fertiliser compared with the highest N input, aboveground DM averaged 4,62 and 15,10 for urea, 5,04 and 15,71 for urea phosphate, 6,43 and 18,22 for urea formiate, 5,97 and 15,67 for IBDU, 5,67 and 15,05 for phosphoryl triamide, and 5,23 and 15,06 g/pot for phosphonitrilic hexamide, respectively. The highest coeffici ts of N utilization were 85% for urea phosphate and 78% for urea formiate. The results suggest that increased N quantities significa tly increased Lolium multifloru yield, and that urea phosphate and urea formiate are effective N fertilisers. Fertiliser calculations should take into account the capacity of the plant to use N from different fertiliser types.

PT: Journal-artic

4.1.16 Nitrogen and Phosphorous Fertigation of Tomato and Eggplant

AU: Papadopoulos-I; Ristimaki-Leena-M; Sonneveld-C (ed.); Berhoyen-MNJ

SO: Proceedings of the XXV International Horticultural Congress. Part 1. Culture techniques with special emphasis on environmental implications, nutrient management, Brussels, Belgium, 2-7 August, 1998.Acta-Horticulturae. 2000, No. 511, 73-79; 32 ref.

LA: English

AB: Field studies, on Pellic Vertisol in Cyprus, were designed to investigate the response of drip-irrigated tomato to conventional soil P- application as Triple Super Phosphate (TSP) and fertigation when P is applied in the form of Urea Phosphate (UP), Monoammonium Phosphate (MAP) or Diammonium Phosphate (DAP). The N and P applied in soil were 300 and 94 kg/ha. An equivalent amount of P and an amount of 70 kg P/ha in a combination with 150, 300 and 450 kg N/ha were applied with irrigation water at a total amount of 200 mm of water. The K applied was 450 kg/ha in all treatments. Irrigation was applied when the soil water potential was between 0,03 and 0,04 MPa and at full plant growth irrigation was equivalent to 0,8 of pan evaporation from a screened USWA Class A pan. Similar treatments were tested on eggplants. The results indicated that fertigation, irrespective of the combination of fertilisers, was superior to soil application. N application was more effici t when applied with the irrigation water. UP as a source of P gave the highest yield in both tomato and eggplants. Results are discussed.

PT: Conference-paper; Journal-article

IB: 90-6605-753-X

AN: 20000310320

4.2 UP-Process and Properties

4.2.1 Comparison of Banded Ammonium Polyphosphate and Acid Urea Phosphate as P Sources for Potatoes

AU: Stark-JC; Ojala-JC
SO: HortScience. 1989, 24: 2, 282-284; 9 ref.
LA: English
AB: In field trials at Aberdeen, Idaho on a Declo silt loam, potatoes cv. Russet Burbank was given 0, 60 or 120 kg P/ha in 1985 and 0, 40 or 80 kg P/ha in 1986 as liquid ammonium polyphosphate (APP) or ammonium urea phosphate (AUP) band-applied above the seed pieces at planting. 120 kg N/ha was applied before planting and 3 applications each of 40 kg N/ha were given via sprinkler irrigation in July and August. Petiole P concentration was higher with APP than AUP for most of the tuber growth period and total tuber yield was 9-15% higher with APP than with AUP. There was little yield response to P rate.
PT: Journal-article
AN: 890727740

4.2.2 Process for Granulation of Fertiliser Materials

AU: Bierman-LW; Edinborough-CR; Johnson-DK
SO: United-States-Patent. 1985,No. 4,554,004, 5pp.; Issued Nov. 19, 1985. Applied Oct. 19,1983. Assigned to J.R. Simplot Company, Boise, Id, USA.
LA: English
AB: Granulated fertiliser materials are prepared using urea phosphate as a granulating agent to assist in the agglomeration of finely divided solid particles into relatively uniformly sized granules. Urea phosphate, prepared by dissolving urea in phosphoric acid, is coated onto finely divided particles of fertiliser materials, and granulation is accomplished at a temperature within the thermoplastic range of the urea phosphate. The urea phosphate plasticizes and induces adherence of the fine particles into relatively uniformly sized granules. Optionally, ammonia gas, clay or micro-nutrients can be added after granulation. [TVA]
PT: Patent
AN: 861905050

4.2.3 Process for the Production of Solid Urea-Nitric Phosphate Fertiliser Products

AU: Sullivan-JM; Kim-YK;Waerstad-KR

SO: United-States-Patent-Office-Defensive-Publication.1985,T105,301, 44pp.; Issued Apr.2, 1985.Applied May 21, 1984.

LA: English

AB: The reaction of phosphate rock with nitric acid and urea produces nitrogen-phosphorous containing slurries, which may be granulated and dried to produce solid N-P fertiliser products with agronomically advantageous low pHs (1,1-4,0). Products with optimum physical and chemical properties were discovered by investigating the characteristics of each individual material as a function of the nitric acid acidulation ratio (mole ratio HNO_3:CaO) and the urea:CaO mole ratio present in each product. Acidulation ratios were 1,2-2,1 while urea:CaO ratios were 1,6-4,0. The products have excellent storage characteristics. The improved properties of these products partially result from the formation of a new compound $Ca(H_2PO_4)(NO_3)$, $CO(NH_2)_2$, which was discovered during the course of the investigation. [TVA]

PT: Patent

AN: 851996818

4.2.4 Liquid (Solution) Fertilisers

AU: Achorn-FP; Faulkner-LC

SO: In Fluid Fertilisers [Potts, J.M., editor].TVA-Bulletin. 1984,Y-185, 76-85; 4 fi ., 3 tab.; 18 ref.

LA: English

AB: Aqua ammonia and liquid solution fertilisers based on urea, ammonium nitrate, superphosphoric acid and urea phosphate are discussed. The inclusion of micro-nutrients in solutions is also considered. [TVA]

PT: Journal-article

AN: 851996999

4.2.5 Improve Your Urea I.Q.

AU: Balay-HL; Slappey-GA
SO: Farm-Chemicals. 1984, 147: 3, 28, 30, 33-34, 36-37; 2 fi .; 8 ref.
LA: English
AB: Urea has not only emerged as the leading solid nitrogen fertiliser in the U.S. but worldwide it exceeds by far other nitrogen materials. The particle size of urea has been a problem in preparing non-segregating bulk blends; however, the newly developed falling curtain granular urea process shows promise of giving particles in a narrow size range which closely match the median particle size of DAP while using less energy, generating less pollution, and making better shaped products than most previous products. Most urea prills have some mechanical weakness leading to degradation during handling and therefore need a hardener or conditioning agent. Urea and ammonium nitrate are completely incompatible in solid form because of the combination's low critical relative humidity (18% at 86 °F). Compatibility of urea with normal and triple super phosphate is limited. Storage of urea in a dehumidified bulk storage building is recommended. Urea-ammonium phosphate fertilisers can be made by combining urea melt with ammonium phosphate slurry and granulating the mixture. A 32% nitrogen solution made from urea and ammonium nitrate is a major source of supplemental nitrogen in liquid fertilisers. Other urea-containing fertilisers include urea phosphates, adducts with sulphuric acid, and sulphur-coated urea. The latter is a controlled release fertiliser.[TVA]
PT: Journal-article
AN: 841986165

4.2.6 Acid Fertilisers

AU: Achorn-FP
SO: Solutions. 1984, 28: 4, 33, 36-39; 3 fi ., 5 tab.; 17 ref.
LA: English
AB: Urea phosphate (UP), an adduct produced by reacting solid urea with wet-process phosphoric acid, has a pH of 1-3. Fluid fertilisers produced from it also have a low pH unless they are ammoniated. Processes are described for producing a high-purity crystalline UP and a granular UP product which contains impurities introduced with the wet-process phosphoric acid. Clear liquid fertilisers can be made from the former. These can be mixed with urea and water to make higher nitrogen grades of low pH or ammoniated to produce a near neutral solution of urea-ammonium polyphosphate. Agronomic tests with low-pH fertilisers and use in irrigation are discussed. Tests have shown the feasibility of producing a solution containing urea nitrate and ammonium phosphate. More tests are planned. [TVA]

PT: Journal-article
AN: 841987921

4.2.7 Urea Phosphate as Granular or Fluid Fertilisers

AU: Blouin-GM
SO: TVA-Bulletin. 1984, Z-165, 12pp.; 8 fi . Presented at TFI-TVA Fertiliser Technology Workshop (Huntsville, Alabama, April 17-18, 1984).
LA: English
AB: Studies have been made of the phosphoric acid-urea adduct, urea phosphate (UP), and of the various granular and fluid fertilisers that can be produced from it. Preparation of the adduct, granulation of impure UP (IUP), and cogranulation with added urea to produce various N:P_2O_5 wt ratios are described. The critical relative humidity is low; however, the handling characteristics of the 16-41-0 IUP are satisfactory. With the addition of excess urea to produce higher N:P_2O_5 wt ratios the product could not be processed in a drum granulator. Fluid-bed granulation is proposed. Preparation of high poly-phosphate suspension fertilisers from IUP and granular and solution products from purified UP a e discussed. [TVA]
PT: Miscellaneous
AN: 841989676

4.2.8 Production of Urea Phosphate

AU: Lewis-H; Dillard-EF
CA: USA, Tennessee Valley Authority.
SO: United-States-Patent. 1984,N°. 4,461,913, 16pp.; Issued July 24, 1984. Applied Nov. 24, 1981. Continuation of United States Patent Office Defensive Publication T103 206.
LA: English
AB: A two-stage continuous crystallization process for production of urea phosphate by reaction of impure wet-process orthophosphoric acid (54% P_2O_5) and urea is improved by the simultaneous addition of a selected acidifying agent (sulphuric acid, hydrochloric acid or phosphoric acid) to clarified mother liquor used as recycle in the process. Addition of the acidifying agent decreases the pH in the crystallization process whereby the solubility of a contaminating water-insoluble iron phosphate-urea salt [$FeH_3(PO_4)2.2CO(NH_2)_2$] is increased. Purity of the crystalline urea phosphate product is thus improved significa tly and the useful storage life of the recycle mother liquor is prolonged. [TVA]
PT: Patent
AN: 841989916

4.2.9 Urea: a Versatile Source of Nitrogen

AU: Kachelmann-DL; Cole-CA Jr.
SO: Paper presented at the 194th National Meeting of the American Chemical Society, New Orleans, LA, USA. 1987, 30 pp.; 14 fi .; 11 ref.
PB: American Chemical Society; Washington; USA
LA: English
AB: In 1986, reduced urea prices caused fertiliser manufacturers to consider using more urea to meet their nitrogen requirements. The paper features an overview showing ways to use urea in combination with ammonium nitrate, ammonium sulphate, ammonia, monoammonium phosphate, phosphoric acid, potassium chloride, and sulphuric acid to produce solutions and suspensions. Methods using urea and phosphoric acid to produce fluid fertilisers containing low polyphosphate contents to improve storability are discussed. Production schemes on using solid urea as a feedstock to produce granular urea-ammonium phosphate and granular urea-ammonium sulphate are described.
PT: Miscellaneous
AN: 891937609

4.2.10 Kinetics of Decomposition of Urea Adducts with Nitric and Orthophosphoric Acids

AU: Zabuga-V-Ya;Vyaz'-mitina-OM; Datsenko-DF; Doroshenko-VN; Ped-LL
SO: Soviet-Progress-in-Chemistry.1987,53: 9,45-47;Translated from Ukrainskii Khimicheskii Zhurnal, 53 9, 937-939 (1987).
LA: English
AB: Acceleration of the urea-decomposition process by introducing additives was studied. Kinetics of urea orthophosphate and nitrate, synthesized for better compatibility of the additive with urea, were investigated gravimetrically. A comparative analysis was carried out of the obtained kinetic parameters and also of derivatograms of urea orthophosphate and urea. Additives with acidic character accelerate the urea-decomposition process as a result of inhibition of formation of thermally stable decomposition products - cyanuric acid and its derivatives. [TVA]
PT: Journal-article
AN: 881922976

4.2.11 Solubility of Soil Phosphorous as Influen ed by Urea

AU: Hartikainen-H;Yli-Halla-M
SO: Zeitschrift-fur-Pflan enernahrung-und-Bodenkunde. 1996, 159: 4, 327-332; 25 ref.

LA: English
LS: German
AB: Ways to mobilize residual fertiliser P as a result of local pH elevation caused by urea hydrolysis were studied. The response of water-soluble P (Pw) and dissolved organic C (DOC) to urea hydrolysis was monitored in three cultivated soils and at two P levels for up to 127-135 d and compared with corresponding changes in soils limed with $Ca(OH)_2$. Hydrolysis of urea was complete in 8-15 d during which soil pH increased by 1-1,5 units at the maximum. Subsequently, the pH decreased to or below the original level due to nitrific tion. Mobilization of soil P was enhanced substantially in parallel with the increase in pH, the peak Pw occurring simultaneously with the highest pH value. In all urea-treated soils, Pw remained at an elevated level for at least 60 days. As compared to urea, elevation of soil pH with $Ca(OH)_2$ only had a minor and inconsistent influen e on Pw. In mobilization of soil P, the urea-induced increase in pH and a simultaneous production of NH_4^+ ions proved to be superior to liming with $Ca(OH)_2$. It was hypothesized that when an acid soil is amended with urea, phosphate is first displaced by OH^- ions, resulting in elevated solution P concentrations. A simultaneous dissolution of organic matter contributes to the persistence of high P concentration by competition for sorption sites on Fe and Al oxides, and thus retards the resorption of P.
PT: Journal-article
AN: 961907748

4.2.12 Theoretical Model of the Reaction Equilibria for the Urea-phosphoric Acid System at the Molar Ratio Less Than One

AU: Babin-MJ; Nenadov-R; Zrnic-Z
SO: Hungarian-Journal-of-Industrial-Chemistry. 1990, 18: 1, 111-123; 13 ref.
LA: English
AB: A theoretical model is presented of the reaction equilibriums for the urea-phosphoric acid system at a molar ratio less than one. The urea-phosphoric acid, urea phosphate mother liquor solution, and the mother liquor solution-phosphoric acid solution mass ratios and efficie y coeffici ts for P_2O_5 and urea were evaluated. The correlations derived for these parameters provide better understanding of the process and could be used in design and control of the urea phosphate production process.
PT: Journal-article
AN: 911959651

4.2.13 Corrosion of Galvanized Steel and Carbon Steel in De-aerated Aqueous Solutions of Industrial Fertiliser Chemicals

AU: Smith-DJ; Schijff OJ-van-der

SO: British-Corrosion-Journal. 1989, 24: 3, 189-191; 11 ref.

LA: English

AB: Corrosion rates of galvanized steel in contact with dilute solutions of various chemicals used as industrial fertilisers were determined by potentiodynamic measurements. De-aerated solutions containing up to 20 g/litre of urea phosphate, phosphoric acid, monoammonium phosphate, zinc sulphate, urea ammonium nitrate, clear ammonium orthophosphate, ammonium sulphate, potassium chloride, ammonium orthophosphate, potassium sulphate, and urea were used in the tests. Uncoated carbon steel was tested in de-aerated solutions of monoammonium phosphate, zinc sulphate, potassium sulphate and ammonium sulphate. The results indicate operating concentrations for satisfactory performance of these metallic materials.

PT: Journal-article

AN: 901948036

4.2.14 Production of High-quality Liquid Fertilisers from Wet-process Acid via Urea Phosphate

AU: Hodge-CA; Motes-TW

SO: Fertiliser-Research. 1994, 39: 1, 59-69; 19 ref.

LA: English

AB: A pilot-plant process is described that purifies wet-process phosphoric acid for the production of a high-quality urea-ammonium polyphosphate base solution. An intermediate product, crystalline urea phosphate, is produced from urea and merchant-grade (54% P_2O_5) wet-process phosphoric acid. The urea phosphate crystals contain only about 15 to 20% of the objectionable impurities (iron, aluminium and magnesium) originally contained in the feed wet-process acid. The urea phosphate crystals are pyrolyzed, converting orthophosphate to polyphosphate with very little energy consumption. The resulting melt is dissolved and neutralized with ammonia to produce 14-29-0 liquid product of high polyphosphate content.

PT: Journal-article

AN: 951902484

4.2.15 A Modified Urea Based NP Fertiliser: Urea-TSP-MAP Combinations

AU: Fan-MX; MacKenzie-AF; Blenkhorn-HD
SO: Fertiliser-Research. 1996, 45: 3, 217-220; 5 ref.
LA: English
AB: Applying urea with acidic phosphate fertiliser increases urea fertiliser efficie y by reducing ammonia volatilization and toxicity to crops from urea hydrolysis. However, urea and triple super phosphate (TSP) are not recommended to be co-granulated because blends might become wet and sticky. Monoammonium phosphate (MAP) is a less acidic P source than TSP, but is compatible with urea. Compound NP fertiliser products made from MAP and TSP combinations as P sources with urea were evaluated in this study. Fertiliser mixtures were pelletized from commercial urea, TSP and MAP with different N:P_2O_5 ratios and MAP/TSP combinations. Moisture changes during storage, pH of fertiliser solutions, and ammonia volatilization from surface applied fertiliser pellets were measured. Using MAP with TSP in urea-P mixtures reduced moisture increases during storage. Increasing MAP in urea-TSP-MAP combinations increased fertiliser solution pH by over 1 unit as the MAP/TSP-P_2O_5 ratio increased from 0/100 to 100/0. Adding MAP as 50% of P in urea MAP-TSP mixtures at 3:1 and 1,5:1 (N:P_2O_5) ratios reduced ammonia loss from urea 50% to 60% compared to urea alone; and ammonia loss was similar to that of urea-TSP combinations. A urea-TSP-MAP fertiliser combination could make effici t use of urea-N by crops by reducing ammonia loss from urea hydrolysis.
PT: Journal-article
AN: 961909500

4.3 Animal Nutrition

4.3.1 Utilization of Nitrogen by Young Sheep During Fattening in Relation to the Form of Nitrogen in the Feed

OT: Utilizarea azotului la tineretul ovin la ingrasat in raport cu natura azotului din regimul de hranire.
AU: Florescu-S; Paraschiv-S; Florescu-A; Bologa-M; Radu-A
SO: Revista-de-Cresterea-Animalelor. 1985, 35: 3, 11-18.
LA: Romanian
LS: French
AB: For 90 days weaning Spanca wethers were given diets supplying similar amounts of energy based on maize, sunfl wer oil meal, soybean oil meal, lucerne hay and maize stalks. In experimental diets 37% of the plant protein of the control diet was replaced by urea, ammonia (ammoniated maize cobs), isobutylidene diurea (IBDU) or urea phosphate. All the sheep were given 12,5 g [15N] urea after which urine and faeces were collected. Utilization of nitrogen for the normal diet was 68,45%, for that with urea 52,18%, for that with ammonia 67,50%, for that with IBDU 69,42% and for that with urea phosphate 71,37%. There was no difference among groups in histology of liver or kidneys.
PT: Journal-article
AN: 861483010

4.3.2 The Effect on the Performance of Dairy Cattle of Plant Protein Concentration and of Urea or Urea Phosphate Supplementation in the Diet

AU: Bruckental-I;Tagari-H;Amir-S; Kennit-H; Zamwell-S
SO: Animal-Production. 1986, 43: 1, 73-82; 33 ref.
LA: English
AB: Israeli Friesian cows after calving in groups of 12 were given all their protein from plant sources; a basal control group (BP) was given concentrate with crude protein (CP) 92 g/kg DM, a medium-protein group (MP) was given a diet with soybean meal (SBM) added to give a CP concentration of 143 g/kg DM, and a high-protein group (HP) was given a diet with SBM added to give a concentration of 180 g/kg DM. Two other groups were given the basal concentrate supplemented with urea (MU) or urea phosphate (MUP) up to about the same CP level as the MP group. The only roughage used was vetch-oats hay at 350 g/kg total DM intake. The cows were given the experimental diets freely throughout lactation. No difference was found between

treatments in DM intake (kg daily), mean milk and fat-corrected milk (FCM; fat 40 g/kg) yields (kg daily), milk protein concentration, days from calving to conception or services per conception, during the entire lactation period. FCM yields during 60 days after calving were significa tly higher for cows given the CP-supplemented diets than for the BP group. The FCM yield of the cows given the HP concentrate was higher than for those given the other concentrate mixtures only during the first 15 days after calving. Milk fat concentration was higher in cows given the BP and HP concentrates than in those given the MP diet, but only a trend in this respect was observed when part of the plant protein was replaced by urea or urea phosphate. The rate of body weight loss after calving tended to increase with increase in amount of plant protein in the diet but was highest for the cows given the diets supplemented with non-protein nitrogen. Later in lactation, the body weights of cows given the MP, HP and MUP diets increased immediately after they reached their lowest weight whereas cows given the BP and MU diets started gaining weight 165 and 120 days after calving, respectively. Rumen ammonia-N and blood urea-N concentrations (mg/litre) for treatments BP, MP, HP, MU and MUP were: 56 and 101; 120 and 226; 143 and 269; 191 and 227; and 179 and 212.

PT: Journal-article

AN: 861487816

4.3.3 Effect of Synthetic Nitrogenous Substances and Amounts Given on Fermentation Processes in the Forestomachs of Fattening Bulls

OT: Einfluss sy thetischer stickstoffhaltiger Substan en und ihrer Niveaus auf die Fermentationsprozesse in den Vormagen von Mastbullen.

AU: Sommer-A; Chrastinova-L; Flak-P; Macho-V

SO:Archiv-fur-Tierernahrung. 1982, 32: 10-11, 719-737; 9 ref.

LA: German

LS: Russian, English

AB: The influen e of 2 amounts of urea, urea phosphate, urea-formaldehyde-condensate, NH_4HCO_3 and urea clathrate on fermentation process in the omasum was studied in 12 experiments on fattening bulls with rumen cannulae. The pH value of the rumen fluid changed in relation to the synthetic compounds given and to the time after feeding. The NH_3 in the rumen fluid was significa tly influen ed by the synthetic compounds given, mainly by their solubility in the rumen flui . NH_3 values in the rumen were lowest after urea-formaldehyde-condensate and NH_4HCO_3, on average 7,0 to 8,8 mg/100 ml (4,1 to 5,2 mmole/litre). NH_3 was the highest between 1,5 and 2,5 h after feeding. The molar proportions of volatile fatty acids in

the rumen fluid varied in relation to the synthetic NPN compounds given and to the time after feeding.
PT: Journal-article
AN: 841451823

4.3.4 Urea Phosphate as a Source of Supplemental Phosphorous for Poultry

AU: Kiiskinen-T
SO: Annales-Agriculturae-Fenniae. 1983, 22: 2, 86-92; 16 ref.
LA: English
LS: Finnish
AB: Three experiments, 1 on laying hens and 2 on broiler chickens, were conducted to compare the biological availability of phosphorous from urea phosphate (UP) with that from the dicalcium phosphate (DP) commonly used in poultry rations. The contents of UP and DP in diets varied from 0,7 to 1,4% and from 0,8 to 1,6%, respectively. In experiment 3 both phosphates were used at levels of 0,24 and 0,40% available P in the diets of broiler chicks. No significa t differences were observed between the phosphates with respect to egg production, final body weight of broilers, efficie y of feed conversion, mortality, serum values, leg weakness or tibia ash content. In experiment 2 on broilers the tibia ash content was significa tly higher (P less than 0,01) with UP than with DP. The average body weight of the UP groups at 3 weeks of age was significa tly higher (P less than 0,05) than that of the DP groups in experiment 3. No significa t difference was found in the rate of growth, mortality, leg weakness or percentage of tibia ash between levels.
PT: Journal-article
AN: 841455837

4.3.5 Use of Maize Silage Containing the Preparation "Somex" in Diets for Sheep

AU: Solov'-ev-AM;Tishenkov-PI; Bocharova-MI
SO: Byulleten'-Vsesoyuznogo-Nauchno-issledovatel'skogo-Instituta-Fiziologii, Biokhimii-i- Pitaniya-Sel'skokhozyaistvennykh-Zhivotnykh. 1987, No. 1-85, 68-71; 4 ref.
LA: Russian
LS: English
AB: A Finnish preparation, "Somex", which is used for preserving grains and wet feed mixtures, is a 1:4 mixture of urea phosphate and pure urea containing 36,6%

nitrogen, 6,5% phosphate and filling substances. Somex is added to grains, straw and other feeds at 2,5 to 5,0% by weight. Two groups of wethers 5 to 6 months old and weighing 23,5 kg were given a daily diet of hay 2,5, feed mixture 0,3 and maize silage, natural or treated with Somex 2,0 kg. Somex was added to the silage at 3% by weight of green herbage. Blood and rumen contents were taken before and 3 hours after the morning feeding. The Somex-treated silage increased the pH and concentrations of volatile fatty acids, protein-, non-protein- and ammonia nitrogen in rumen contents and of urea in blood; it decreased the efficie y of utilization of nitrogen.

PT: Journal-article

AN: 891421024

4.3.6 Effect of Urea Phosphate in Diets for Wethers on Some Physiological Indices

AU: Sandev-S; Petkova-M

SO: Zhivotnov"dni-Nauki. 1987, 24: 5, 86-90; 11 ref.

LA: Bulgarian

LS: Russian, English

AB: In 4 experiments, 4 wethers with fistulae were given diets of maize grain, grass hay and starch and urea (experiments 1 and 3) or urea and urea-phosphate (UP) (experiments 2 and 4). Urea in the first 2 experiments totalled 47%, whereas in the last 2 experiments it was 40%. In wethers that were given the urea and UP mixture, ammonia in ruminal fluid 0, 1 and 4 hours after feeding was lower than in other groups, indicating more intensive protein utilization. The amount of urea in the blood, 0 and 2 hours after feeding, was also lower. Apparent digestibility of nutrients was similar to that with urea alone. UP decreased nitrogen excretion/g intake in urine by about 10%.

PT: Journal-article

AN: 871401892

4.3.7 Comparative Study of Diet Utilization in Balance Experiments with Wethers

AU: Sandev-S; Petkova-M

SO: Zhivotnov'dni-Nauki. 1990, 27: 3, 30-35; 18 ref.

LA: Bulgarian

LS: Russian, English

AB: In 11 trials with 4 wethers, diets containing 8, 10, 12 or 14% protein and

different non-protein nitrogen (NPN) sources (urea, starea and urea phosphate) and based on sugar beet and meadow hay, sunfl wer meal and starch were used. DM intake was similar, about 930 g, in all trials. Replacing about 40% of natural N sources with NPN had no effect on digestibility of total N but had an adverse effect on N utilization. N in urine increased and N retention decreased. Inclusion of sugar beet in diets increased digestibility of crude fib e and N utilization. Readily soluble phosphorous from urea phosphate improved N utilization and decreased urea in blood. Starea in diets improved utilization of urea N. With increasing protein in the diet protein digestibility increased.
PT: Journal-article
AN: 901427384
Record 190 of 212 in CAB Abstracts 1995

4.3.8 Availability of Phosphorous from Urea Phosphate in Animal Nutrition

OT: Biodisponibilidad del fosforo de la urea fosfato en la nutricion animal.
AU: Godoy-S; Chicco-CF; Leon-A
SO: Zootecnia-Tropical. 1995, 13: 1, 49-62; 16 ref.
LA: Spanish
LS: English
AB: In 2 experiments, using chickens and sheep, phosphorous availability from urea phosphate or dicalcium phosphate was studied. In the chicken trial, the criteria used were body weight gain, bone ash content and apparent P retention. In sheep, efficie y of P utilization was estimated at 2 levels of P intake. Taking P availability from dicalcium phosphate as 100%, P availability from urea phosphate was 94,6 to 96,6% in chickens, and 116% in sheep.
PT: Journal-article
AN: 951414319

4.3.9 Utilization by Sheep of Carotene in Diets Based on Silage Supplemented with Different Nitrogen Sources

OT: Utilizarea la ovine a carotenului din ratii pe baza de siloz, suplimentate cu diferite surse de azot.
AU: Turcu-D; Rotunjeanu-E
SO: Lucrarile-Stiintifi e-ale-Institutului-de-Cercetari-pentru-Nutritie Animala.1982,11:83-87; 12 ref.
LA: Romanian

LS: English, French, German, Russian
AB: Wether sheep were given daily 2 kg maize silage and 500 g concentrate without or with 37% of plant protein replaced by urea, ammonium sulphate or urea phosphate. The diets supplied 52,10 to 52,57 mg carotene daily and 29,17 to 30,86 mg vitamin E. Digestibility of carotene was 54%, 48%, 42,4% and 42,5%, respectively. Vitamin A was 70, 51, 5, 43 and 36 IU/100 ml serum and vitamin E was 0,142, 0,094, 0,080 and 0,080 mg/100 ml.
PT: Journal-article
AN: 841456398

4.3.10 Phosphorous Bioavailability

AU: Soares-JH Jr.;Ammerman-CB (ed.); Baker-DH (ed.); Lewis-AJ
SO:Bioavailability-of-nutrients-for-animals:-amino-acids,-minerals,-and-vitamins.1995, 257-294; 163 ref.
PB: Academic Press; San Diego; USA
LA: English
AB: In this chapter the importance of phosphorous in the skeleton and in many key metabolic processes and the need for supplementation of diets, especially for non-ruminants, are discussed. The variation in P availability from plant products and commercial supplements can be quite large. Since P is an expensive ingredient in the diet, a knowledge of P bioavailability is critical to effici t animal production. The discussion of P bioavailability studies is divided into non-ruminant (mainly chickens and pigs) and ruminant (sheep and cattle) sections. Dietary factors influencing bioavailability are covered particularly in relation to calcium and phytic acid. Research on bioavailability of P sources is summarized over 22 pages of tables. The P in many inorganic sources and in meat and fish meals is highly available to monogastric animals. In general, when compared with several highly available standard sources, sources and feedstuffs with greater than 95% phosphorous bioavailability include ammonium polyphosphate, dicalcium phosphate, fish meal, meat meal, meat and bonemeal, monocalcium phosphate, potassium phosphate monobasic, monosodium phosphate, phosphoric acid, poultry by-product meal, tricalcium phosphate and urea phosphate. Somewhat less available (85 to 90%) are bone meal, blood meal, Curacao Island phosphate, defluo inated phosphate and dried poultry waste. Low P bioavailability for non-ruminants has been reported for lucerne meal, cereal grains and most oilseed meals. Essentially all the P in metaphosphates and pyrophosphates is unavailable to non-ruminants. Ruminants, however, appear able to utilize these sources to a greater degree. Microbial phytase added to diets for poultry, pigs and fish appears to increase phytate phosphorous bioavailability by as much as 50%.

Recent evidence showed that adding 5 to 10 mugs of dihydroxycholecalciferol to a vitamin D adequate diet also increased phytate-P bioavailability by 50%.
PT: Book-chapter
IB: 0-12-056250-2
AN: 961405604

4.3.11 Urea Phosphate in Feeds for Sheep

OT: Karbamidofosfat"t pri khranene na ovtse.
AU: Stoikov, D.; Shishkov, I.
SO: Veterinarnomeditsinski Nauki vol. 13 (8): p.43-47
PY: 1976
LA: Bulgarian
LS: Russian; English
AB: Replacing 6 g urea with 15 g urea phosphate in the feed of yearling Pleven blackface sheep significa tly improved the digestibility of lipids by 11,12 percentage units, of crude proteins by 5,10 and of P by 10,0. Utilization of dietary N improved intake from 24,25% to 43,54% and mean weight gain in 60 days increased from 1,7 kg to 4,0 kg. The ration consisted of 1.000 g meadow hay, 300 g maize meal, 100 g barley meal, 5 g limestone and 10 g NaCl, with 6 g urea or 15 g urea phosphate. Carcass dressing percentage was 3,5 units greater and the meat contained more protein and less fat with urea phosphate. 13 ref.
PT: Journal article
AN: 19761451455

4.4 Hygiene

4.4.1 Effect of Urea Phosphate with Bentonite on Microflo a of Poultry Manure

OT: Wplyw fosforanu mocznika z bentonitem na mikroflo e gnojowicy dro-biowej.

AU: Grata-K; Latala-A; Krzysko-Lupicka-T; Nabrdalik-M

SO: Medycyna-Weterynaryjna. 1999, 55: 8, 546-549; 28 ref.

LA: Polish

LS: English

AB: The effect of urea phosphate with bentonite on the microflo a of poultry manure was investigated. Disinfection was carried out under laboratory conditions. A solution of 10% urea phosphate and 4% bentonite was used during testing. Samples were taken 3 times every 2 weeks. Poultry manure before application of the preparation was used as the control. The total concentrations of bacteria and fungi in manure before application of urea phosphate with bentonite were 3,97 X 108 cfu/cm^3 and fungi 7,7 X 102 cfu/cm^3, respectively. The preparation caused a decrease in the total number of bacteria of about 99,99% and of fungi of about 82,86% in the 6th week of examination. Coli titre from 2 weeks increased by > 0,1 X 10-1. Qualitative examination of crude poultry manure showed presence of potentially pathogenic bacteria; E. coli, Salmonella OC, OD, Klebsiella sp., Staphylococcus "co+" and Pseudomonas aeruginosa, and fungi; Mucor sp., Rhizopus sp., Cladosporium sp., Aspergillus sp., Penicillium sp. and Geotrichum sp. six weeks after application of urea phosphate with bentonite Micrococcus sp., Bacillus sp., Clostridium sp. and Penicillium sp. were isolated.

PT: Journal-article

AN: 19992213907

4.5 Plant Growth Regulators + Ultrasol™ Magnum P44

4.5.1 Effect of Acidified GA3 Sprays on Yield of Globe Artichoke (Cynara Scolymus L.)

AU: Basnizki-Y; Goldschmit-E; Luria-Y; Itach-M; Berg-Z; Galili-D
SO: Hassadeh. 1986, 66: 9, 1814-1817; 9 ref.
LA: Hebrew
LS: English
AB: Israeli growers spray 3 times with 120 ppm GA3 to shift the production of cv. Blanc d'Hyeres from spring to early winter. However, this treatment can cause head deformation. It was shown in many field trials using vegetatively propagated material under various climatic conditions that GA3 at 60 ppm in urea-phosphate acidified solution (pH 4) was as effective as 120 ppm GA3 in tap water. Moreover, there were no deformed heads.
PT: Journal-article
AN: 860338489

4.5.2 Enhanced Effect of Gibberellin on Grape Size by Addition of Urea Phosphate

AU: Shulman-Y; Bazak-H
SO: Alon-Hanotea. 1986, 40: 9, 761-766; 9 ref.
LA: Hebrew
LS: English
AB: Adding 0,1% urea phosphate to 7,5-30 mg/litre GA reduced the pH of the solution to 2,9. Sprays of the mixture after fruit set produced a greater increase in berry size of cv. Thompson Seedless sultana than GA alone. Adding a citrate buffer (pH 2,9) to GA had no effect on berry size.
PT: Journal-article
AN: 860339302

4.5.3 Effects of Climatic Districts, Orchard Treatments and Seal Packaging on Citrus Fruit Quality and Storage Ability

AU: Monselise-SP
SO: Proceedings of the International Society of Citriculture, 1981. Volume 2. 1983, 705- 709; 20 ref.
PB: Fruit Tree Research Station; Shimizu; Japan

LA: English
AB: The application of 20 ppm GA3 + 18 ppm 2,4-D + 1% urea phosphate in mid-July to Shamouti oranges due to be harvested the following February led to lower values for the rheological parameters of softness (S) and deformation (D) in storage. Treated fruits had a higher S/D ratio, a delayed decrease in juice acidity and a delayed increase in the ratio of TSS:juice acidity, as well as a lower incidence of rots. Seal packaging in high density polyethylene film further improved rheological properties but had little effect on fruit components and led to increased rotting, especially after long storage. Internal quality was slightly better and rotting percentage after long storage much smaller in relatively drier producing areas. Rheological properties, however, were less satisfactory. With Marsh Seedless grapefruit, relatively drier interior areas (about 25 km from the sea and shielded by mountain ranges) provide the best fruit for long storage. A wide range of daily temperatures (May to August), strong evaporation in summer and medium rainfall in winter were linked with less advanced internal maturity (more acidity), a thicker peel, low rotting percentage and relatively low S and D at late harvest and after storage at 11 °C for more than 20 weeks with 1 week of shelf life. Fruit characteristics and storage are discussed in relation to climate. [For related work see HcA 49, 4558.]
PT: Conference-paper
AN: 840321261

4.5.4 Effect of Nitrogen, Phosphorous and GA3 on Chemical Composition of Guava (Psidium Guajava L.) cv. Allahabad Safeda during Winter Season

AU: Singh-DS; Singh-SP; Maurya-AN
SO: Progressive-Horticulture. 1990, publ. 1993, 22: 1-4, 1-5; 10 ref.
LA: English
AB: Nitrogen (as urea), single super phosphate and GA3 were applied at different concentrations, alone or in combination, as a foliar feed to 1987 and 1988 winter crops of guava cv. Allahabad Safeda, growing in the field in Varanasi, in early July. Fruits were harvested when light green. Urea at 2 and 4% increased the ascorbic acid and pectin contents of fruits, phosphate at 2% increased the percentage of TSS, reducing sugars, non-reducing sugars and pectin, and GA3 at 100 ppm increased the ascorbic acid content, compared with untreated plants. Fruit quality was generally improved by the addition of urea, phosphate and GA3 in combination.
PT: Journal-article
AN: 930321948

4.5.5 Pre-Sowing Seed Treatment and its Role on Germination, Seedling Growth and Longevity of Papaya

AU: Sen-SK; Hore-JK; Bandyopadhyay-A

SO: Orissa-Journal-of-Agricultural-Research. 1990, 2: 3-4, 160-164; 7 ref.

LA: English

AB: Fresh papaya [pawpaw] seeds collected from the University Research Farm, Kalyani, were treated with 200 ppm GA3, 10-3 M sodium phosphate (dibasic), sodium chloride, ferulic acid, thiourea, GA3, tannic acid, or water for 8 h or 16 h. Further treatments consisted of coating the seeds in one of two gum Arabic pastes. Paste I comprised potassium dihydrogen phosphate, urea and ammonium nitrate each at 1 g/100 g seeds. Paste II was similar to paste I with the addition of 100 ppm GA3 and 100 ppm Agromin [a micro-nutrient formulation]. The effects of low temperature (10 °C) treatment for 8 or 16 h were also tested. After treatment, the seeds were dried and stored in polyethylene bags. Seeds were sown in seed pans in the nursery at 9 or 140 days after treatment. Untreated seeds were sown as a control. All treatments, except the paste treatments in the 140-day sowing increased percentage germination compared with the control. In the 9-day sowing, percentage germination was highest with ferulic acid for 16 h (95%), followed by chilling for 8 h (93,2%), and paste II (92%). In the 140-day sowing, percentage germination was highest with tannic acid for 8 h (66,7%), followed by 200 ppm GA3 for 8 h (58,5%); no germination occurred with the paste treatments. For both sowings, seedling height and leaf number were greatest with the 8h treatments with 200 ppm GA3 or sodium phosphate.

PT: Journal-article

AN: 930324691

4.5.6 Enhancement of IBA Stimulatory Effect on Rooting of Olive Cultivar Stem Cuttings

AU: Wiesman-Z; Lavee-S

SO: Scientia-Horticulturae. 1995, 62: 3, 189-198; 20 ref.

LA: English

AB: Three groups of olive cultivars were characterized as showing low, moderate or high rooting percentage after IBA treatment. To improve the rooting of olive cuttings, urea phosphate (UP) and paclobutrazol (PB) were tested in combination with 0,8% IBA. UP alone at up to 5 g per litre did not stimulate rooting of olive cuttings; however, when applied together with IBA it significa tly enhanced the rooting of cultivar Manzanillo cuttings. PB alone at up to 5 g/litre had a weak effect on rooting of cuttings but in combination with IBA it improved the rooting of cultivars Manzanillo and Souri. A triple combination of IBA, UP and PB provided the most effective treatment for the improvement of rooting percentage. IBA treatments increased the number of roots per cutting in comparison with the control, but decreased the length of the roots of cultivar Barnea. IBA plus UP or PB further increased the number of newly formed roots. However, IBA plus UP markedly increased root length. The triple combination treatment did not differ from IBA plus PB regarding root number per cutting, but the roots were longer than in IBA treated and control cuttings. The survival of rooted cuttings treated with IBA was relatively low for all cultivars tested. IBA plus UP plus PB improved the survival of the rooted olive plants compared with IBA alone.

PT: Journal-article

AN: 950311318

4.5.7 Paclobutrazol and Urea Phosphate Increase Rooting and Survival of Peach "Maravilhae" Softwood Cuttings

AU: Wiesman Z; Riov J; Epstein E

SO: Journal: HortScience, 1989, 24 (6) 908-909

PY: 1979

LA: English

AB: Paclobutrazol treatment combined with IBA and urea phosphate significa tly enhanced the rooting of softwood peach (Prunus persica L. Batsch) Maravilha cuttings. Application of paclobutrazol to the mother plants 8 months before removal of cuttings was more effective than application directly to the cuttings. The survival rates of rooted cuttings obtained from paclobutrazol treated plants were significa tly higher than those obtained from untreated plants.

ISSN: 0018-5345

4.5.8 Gibberellic Acid Sprays for Reducing Creasing in Valencia

AU: Sadowsky-A; Greenberg-J; Hertzano-J

SO: Alon-Hanotea. 1987, 41: 5, 475-479; 14 ref.

LA: Hebrew

LS: English

AB: Spraying 20 ppm GA with 0,2% urea phosphate or 0,1% phosphoric acid in late July was equally effective in reducing fruit creasing in Valencia orange. A spray of 20 ppm GA + 1% urea phosphate sometimes caused peel phytotoxicity. GA sprays with L-77 surfactant reduced creasing but caused necrotic spots on the peel.

PT: Journal-article
AN: 870343638

4.5.9 Effect of the Application of Gibberellic Acid, Urea Phosphate, Ethephon and Putrescine at Different Flowering Dates, on Fruit Setting of Table Grapes (Vitis Vinifera L.), Cv. Thompson Seedless

OT: Efecto de la aplicacion de acido giberelico, urea fosfato , ethephon y putrecina en diferentes epocas de flo acion sobre la cuaja, en uva de mesa (Vitis vinifera L.), cv. Thompson Seedless
AU: Rebolledo S, Sergio Eugenio
SO: Universidad Catolica de Chile, Santiago (Chile). Fac. de Agronomia.
PU: Santiago (Chile) , 1992 , 69 p.
DT: Monograph , Dissertation, Bibliography, Summary, Non-conventional Literature
PY: 1992
LA: Spanish
LS: Spanish

The target of the trial was to increase chemical pruning during fl wering and consequently reduce fruit set and reduce manual labour cost. The trial was carried out during the 1989-1990 season. The effectiveness of applications with GA (5, 10 and 15 ppm), urea phosphate (0,5%, 1,0% and 1,5%), GA in combination with urea phosphate (10 ppm and 1,0%, respectively), putrescine (160 and 1.600 ppm) and ethephon (2,5 ppm), during three moments of fl wering (pre-fl wering, initial fl wering and full fl wering), in Thompson Seedless table grapes, in an orchard in the central zone (Pirque, Region Metropolitana, Chile) was tested.

A statistically significa t interaction between moment of application and doses was found for GA and putrescine, in relation to the percentage of fruit set, berry number per cm of shoulder and berry number per cm of rachis, the last one only with GA.

High doses of GA (10 and 15 ppm) were effective in the reduction of fruit set, berry number per cm of shoulder and berry number per cm of rachis, when applied during pre-fl wering and at initial fl wering. On the contrary, applications during full fl wering did not lead to the same results. GA at 5 ppm resulted in the highest reduction of the fruit set percentage.

At initial fl wering, GA at 10 ppm was the only treatment that reduced effectively the percentage of fruit set, the berry number per cm of shoulder and berry number per cm of rachis.

Putrescine (1.600 ppm) applied during full fl wering, significa tly increased fl wer drop. The combination of urea phosphate (1%) and GA (10 ppm) increased the thinning effect when applied during full fl wering.

Ethephon (2,5 ppm) applied during full fl wering, decreased fruit set too. Urea phosphate applied as a single application gave erratic results on the three parameters studied.

In practical terms, the effectiveness of the pruning agents tested was not found to be relevant in any of the three treatments.

AGRIS No: 94-022239

4.6 Silage

4.6.1 The Effect of Formic Acid and Urea Phosphate-Calcium Propionate on Amino Acids in Wheat Silage

AU: Ashbell-G;Theune-HH; Sklan-D
SO: Journal-of-Agricultural-and-Food-Chemistry. 1984, 32: 4, 849-852; 20 ref.
LA: English
AB: Chopped wheat plants were ensiled with or without addition of 0,4% formic acid (FA) or 2,2% urea phosphate-calcium propionate (UP.CaP). Analyses were made after 90 days and after a further aerated silage (AS) period of 7 days. Total amino acid (TAA) content in DM remained stable during the fermentation period but decreased during aeration in the untreated material (UM). Concentrations of essential amino acids (EAA) decreased during fermentation, especially in UM. Free amino acids (FAA) were < 10% of TAA in fresh material but were high in ensiled material and reached about 73% in silage. These values decreased in AS to 63% in the UM, to 54% in the FA-treated, and to 67% in the UP.CaP-treated material. The ammonia N content increased during fermentation in UM and especially in the UP.CaP treatments, whereas this process was decreased by FA. The concentrations and changes of 20 AA are given. The highest AA concentrations in fresh material were those of arginine, lysine, alanine, glutamic acid, leucine, aspartic acid and glycine. The most marked increments in AA as a result of fermentation were ornithine, asparagine, gamma-aminobutyric acid and methionine. There were marked decreases in arginine and glutamic acid. FA increased mainly tyrosine, arginine, serine and glutamic acid, whereas gamma-aminobutyric acid, glutamine and methionine were decreased. UP.CaP increased arginine, tyrosine and histidine and decreased gamma-aminobutyric acid and methionine.
PT: Journal-article
AN: 851465040

4.6.2 Changes in Amino Acid Compounds of Wheat Plants During Ensiling and Aerobic Exposure: the Influen e of Propionic Acid and Urea Phosphate-Calcium Propionate

AU: Ashbell-G;Theune-HH; Sklan-D
SO: Journal-of-Agricultural-Science,-UK. 1984, 102: 3, 667-672; 15 ref.
LA: English
AB: Changes in distribution of amino acid N of chopped wheat plants ensiled at shooting and fl wering when wilted, and at the milk and dough stages as fresh material, were determined as affected by addition of 0,8% propionic acid (PrA) or 2,2% urea phosphate calcium propionate (UP-CaPr). Analyses were carried out

after an ensiling period of 90 days and after a further aerobic exposure period (AE) of 7 days. Total amino acid (TAA) contents in the DM during the fermentation period and in the AE were stable in untreated material (UM) and treated material. Essential amino acid concentration decreased during fermentation, this decrease being higher in the UM. The free amino acids were low in the fresh material (18,6% of TAA) but increased in the ensiled material to ca. 71% of the TAA in the silage. In the AE this level was 63% in UM and 69% in treated material. The ammonia-N contents increased during fermentation in UM and especially in the UP-CaPr treatments, while the opposite occurred in the PrA treatments. The concentration of and changes in 21 amino acids are given. The highest amino acid concentrations recorded in the fresh material were those of arginine, lysine, glutamic acid, alanine, leucine, proline and glycine. The most marked increments in amino acids as a result of fermentation were those of ornithine, gamma-amino butyric acid, threonine and methionine. Marked decreases were observed in glutamine, arginine and glutamic acid. PrA mainly increased arginine, asparagine and glutamine, whereas gamma-amino butyric acid decreased; UP-CaPr increased arginine, asparagine, lysine and glutamic acid (in silage only) and reduced gamma-amino butyric acid and glutamine in AE only.
PT: Journal-article
AN: 840765596

4.6.3 Treatment of Straw with Ammonia, Urea or an Urea + Urea Phosphate Mixture: Effect on Dietary Intake and Growth of Young Ayrshire Bulls Raised for Beef

AU: Alaspaa-M
SO: Annales-Agriculturae-Fenniae. 1986, 25: 2, 91-97; 18 ref.
LA: English
LS: Finnish
AB: Oat straw was treated with ammonia (A), urea solution (US), urea granules (UG), urea + urea phosphate mixture (3 + 1) solution (UUFS) or urea + urea phosphate mixture (3 + 1) granules (UUFG). The aim of the dosage was to add nitrogen at 25 kg/t DM. Straw dried on the field was used as the control (C). The feeding experiment was made with Ayrshire bulls between 139 and 345 days of age. In vivo digestibility was estimated using wethers. Losses of additives from straw were higher with granules than by spraying. The quality of all straws was good during winter and spring and mould growth did not become apparent until the summer. The total N content of straw was increased by these ammonia-based treatments. However, their influen e on the digestibility of the organic matter of straw and the energy value in fattening feed units was slight and non-significa t. Further, the treatments did not significa tly increase daily live weight gain, carcass weight or the voluntary intake

of straw. It is concluded that the protection of moist straw against mould is the most important function of the ammonia-based treatments. Treatment with liquid urea was found to be the most economical and practical.
PT: Journal-article
AN: 871491805

4.6.4 Effect of Treatment with Urea Or a Urea + Urea Phosphate Mixture on the Nutritive Value of Whole Crop Silage

AU: Alaspaa-M
SO: Annales-Agriculturae-Fenniae. 1986, 25: 2, 99-103; 4 ref.
LA: English
LS: Finnish
AB: Whole crop silage was made from barley treated with urea solution (US), urea granules (UG), urea + urea phosphate (3 + 1) mixture solution (UUFS) or urea + urea phosphate mixture granules (UUFG). The barley was cut at the yellow or dough stage of maturity. The aim of application was to add 25 kg nitrogen/t DM of raw material. The prepared silages were tested on Ayrshire bulls aged between 115 and 412 days. Silages were given ad lib. and barley meal was given at 3 kg daily. Differences between urea or urea + urea phosphate treatments in average daily live weight gain or carcass weight were non-significa t. The DM intakes of silages were: US 3,45, UG 3,14, UUFS 3,13 and UUFG 3,44 kg, respectively. Intakes of US- and UUFG-treated silages were significa tly higher than those of the other treatments. In digestibility trials with wethers the digestibility of organic matter was not significa tly different between treatments or maturity stages.
PT: Journal-article
AN: 871491810

4.7 Other Applications

4.7.1 Chemical Modification of Spruce Bark and the Possibility of Utilizing It

OT: Chemicka modifakcia smrekovej kory a moznosti jej vyuzitia v praxi.
AU: Melcer-I; Melcerova-A
SO: Zbornik-Vedeckych-Prac-Drevarskej-Fakulty-Vysokej-Skoly-Lesnickej-a-Drevarskejvo-Zvolene. 1989, No. 1, 47-56; 20 ref.
LA: Slovakian
LS: Russian, English, German
AB: Bark of spruce (Picea abies) was extracted with water, 20% solutions of urea and urea phosphate, and 1%, 2% and 5% NH_4OH. The bark was then used alone or in mixture with peat as a nursery substrate for growing Scots pine (Pinus sylvestris) seedlings, and the bark extract was used in the manufacture of adhesives. Data are tabulated on the dimensions of the pine seedlings grown in the various substrates, and on the chemistry of the bark extracts.
PT: Journal-article
AN: 950618834

4.7.2 The Fire-Resistance of Wood Materials Treated with Dimethylphosphite

AU: Pokrovskaya-EN; Makovskii-Yu-L; Sidorov-VI; Osadchenko-IM
SO: Izvestiya-Vysshikh-Uchebnykh-Zavedenii,-Lesnoi-Zhurnal.1991,No.6,57-59;6 ref.
LA: Russian
AB: Differential thermal analysis and gas pyrolytic chromatography were used to investigate the thermal breakdown of wood in the presence of dimethylphosphite (DMP) at rates of 2,5, 5 and 10%. The results showed that DMP significantly improved the fire-resistance of wood. When urea phosphate (UP) was introduced into an aqueous solution of DMP, the evolution of CO during wood pyrolysis was reduced by 22% and the yield of coke residue was increased by 15%. To form a fire-retardant preparation the best ratio of DMP to UP was 1:0,65; when wood was treated with this preparation the penetration depth was 7 mm, and the treated wood had higher strength properties than untreated wood.

Application of 500-600 g of the preparation per m^2 allows the wood to be classed as fire-retardant.
PT: Journal-article
AN: 950610625

5 UP Patents

Various patents exist between UP and other fertiliser salts. In this Chapter they are summed up and discussed. Chapter 5.1 discusses the most relevant UP patents for SQM, which are held by OMS Investments Inc. Chapter 5.2 presents a schematic overview of Kemira's urea phosphate patents, whereas Chapter 5.3 features a comprehensive review of urea phosphate patents. This study was finished on January 8, 2006.

5.1 Urea Phosphate Patents – Status OMS

This Chapter presents the status of UP patents held by OMS in the USA and Europe, followed by a summary of the global situation. It also offers alternative mixes based on UP, free of patents.

5.1.1 USA

OMS Investments Inc (Scotts) has several patents in the USA. The first independent claims in the patents US5454850, US5171349, US5492553 and US5395418 are related to a solid product containing urea phosphate and calcium nitrate, calcium chloride or calcium phosphate (MCP, DCP, ICP) as principal calcium sources and as a stock solution of this.

In some patents (US5395418, US5171349, US5492553) a second claim of urea phosphate with (non-chelated) trace metal salts is included. In these patents trace elements are defined as: calcium, iron, magnesium, manganese, boron, molybdenum, copper and zinc sulphates, chlorides, nitrates or lignosulfonates.

5.1.2 Europe

EP569513 is the basis for patents in Europe and concerns a mix of UP and a simple Ca-salt. The patent is granted in Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, Great Britain, Greece, Italy, the Netherlands and Sweden.

The claim reads as follows: a solid complex fertiliser for dissolving in water to give a water-based phosphorous and calcium containing stock solution, characterized in that the solid complex fertiliser comprises a physical mixture of: 5-95% by weight of urea phosphate as the principal phosphorous source and 5-95% by weight of a simple salt of calcium, and that the stock solution, obtained by dissolving the fertiliser in water, is precipitate-free.

It is noteworthy to mention, that patent application EP0771774 was refused (UP + non-chelated TE), also after OMS appealed to the refusal several times. On 29/03/2006 the result of the Appeal Procedure was: APPEAL OF APPLICANT REJECTED, which was published on 05/07/2006. (http://www.epoline.org/portal/public/registerplus) (Annex 4).

This means that UP + chelated or non-chelated TE, or in general UP based acid NPKs with trace elements, are free to be used everywhere in Europe.

5.1.3 Summary Patent Situation in the USA, Europe and Other Countries

Table 62 shows a simplified summary of patents valid in the USA and in the most important horticultural countries in Europe.

Table 62. Simplified summary of patents valid in the USA and in the most important horticultural countries in Europe.

Type of patent	Patent Status		
	USA	PCT*** (without Europe), TR	Europe
Ultrasol™ Magnum P44 + simple Ca-salt*	granted	granted	granted
Ultrasol™ Magnum P44 + TE (non-chelated)**	granted	granted	rejected

* Simple Ca-salt: nitrate, chloride, phosphate.

** Trace metal salt: calcium, iron, magnesium, manganese, boron, molybdenum, copper and zinc sulphates, chlorides, nitrates or lignosulfonates. This means that chelated trace elements are excluded from the patent.

*** The following PCT member states were designated at the time of filing: European Patent (Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, United Kingdom, Greece, Italy, Luxembourg, Monaco, the Netherlands, Sweden); Australia, Barbados, Bulgaria, Brazil, Canada, Switzerland, Finland, United Kingdom, Hungary, Japan, People's Republic of Korea, Republic of Korea, Sri Lanka, Madagascar, Malawi, Norway, Romania, Russian Federation, Sudan, Sweden.

The following countries were designated to be pursued into the National Phase: Europe, Canada, Australia.
The application was published on August 20, 1992 as WO 92/13813.

5.1.4 UP Based Mixes, Free of Patents

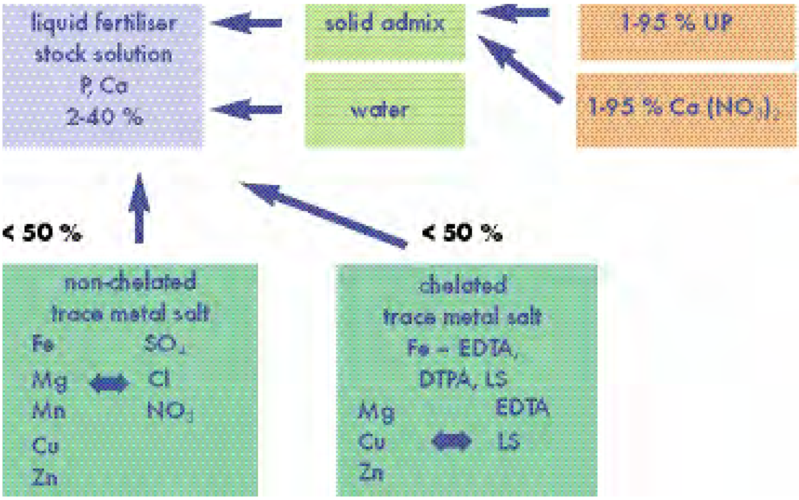
UP based wsNPK mixes, free of patents are:
1. The Ultrasol™ Magnum Flex concept is worldwide free of patents, since it does not contain calcium and/or trace elements.
2. UP and CaO, $Ca(OH)_2$ or $CaCO_3$ and/or MgO, $Mg(OH)_2$ or $MgCO_3$.
3. In Europe any acid NPK, based on UP, with or without trace elements (chelated and/or non-chelated), free of a simple calcium salt (calcium nitrate or calcium chloride) can be produced and sold.
4. In the USA any acid NPK, based on UP, with chelated trace elements only (e.g. Fe, Zn, Mn, Cu), but excluding any micro-nutrient trace metal salt (calcium, iron, magnesium, manganese, boron, molybdenum, copper and zinc sulphates, chlorides, nitrates or lignosulfonates), free of a simple calcium salt (calcium nitrate or calcium chloride) can be produced and sold.

5.1.5 General Remarks

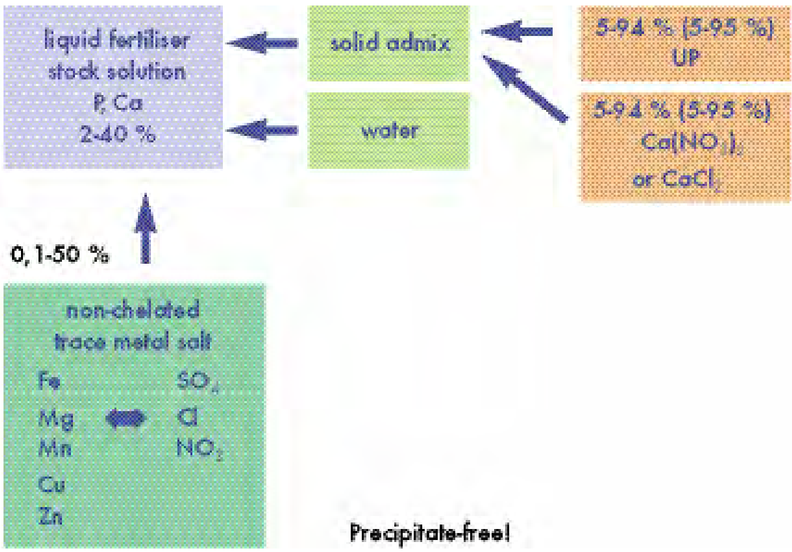
Most patents relevant to SQM expire on or before January 31, 2011. It is advised to check with a local attorney to know the latest patent status.

5.1.6 Schematic Overview of the Protected Technology by OMS

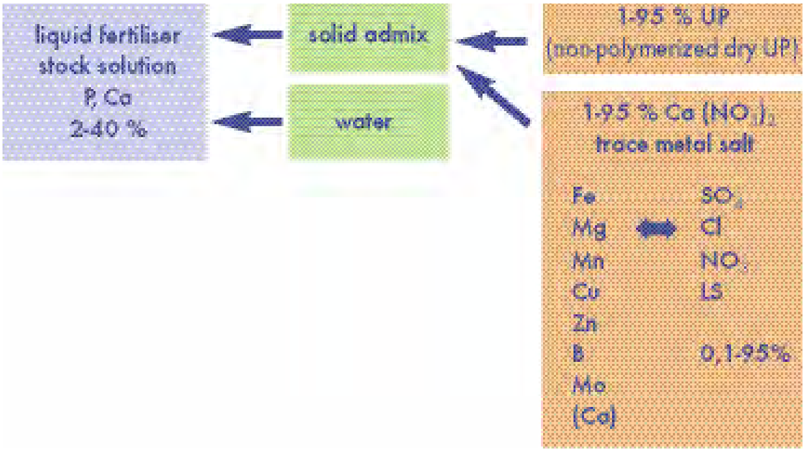
US 5395418 and US 5171439.



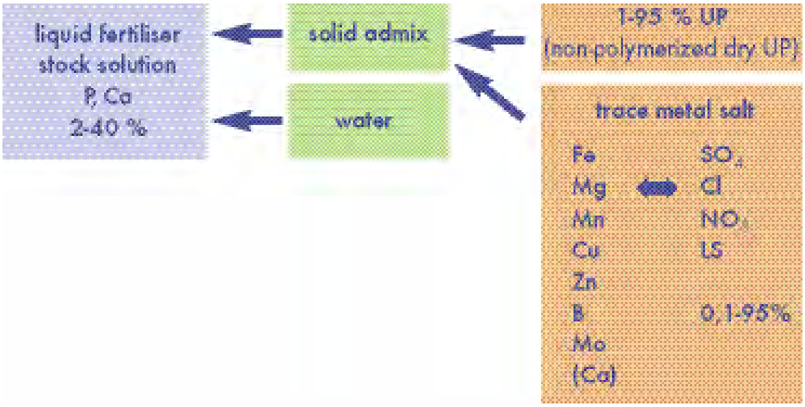
US 5395418 and US 5171349.



US 5395418, US 5171349 and US 5492553.

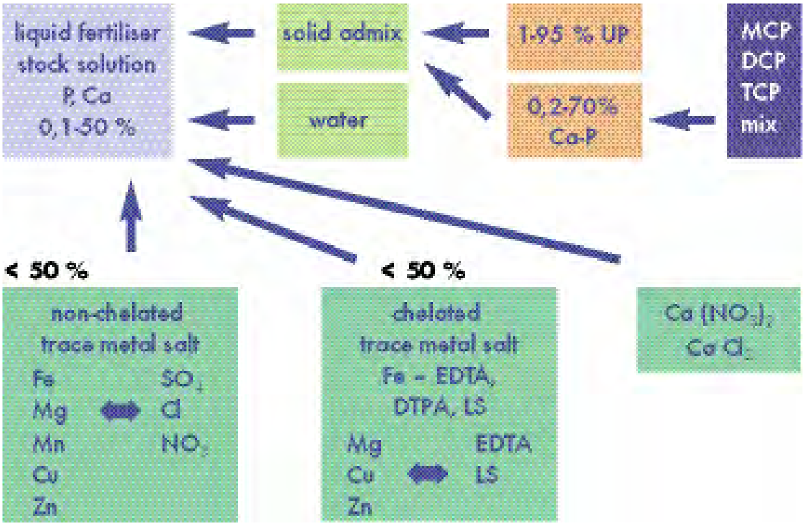


US 5395418, US 5171349 and US 5492553.

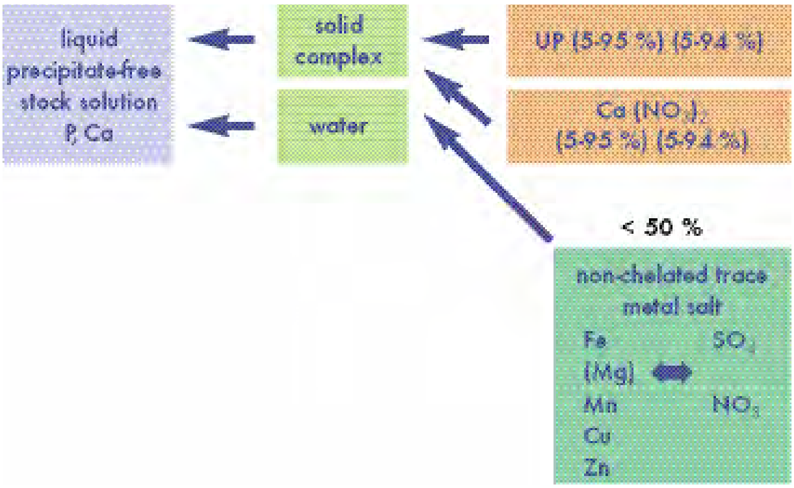


US 5395418.

US 5454850.

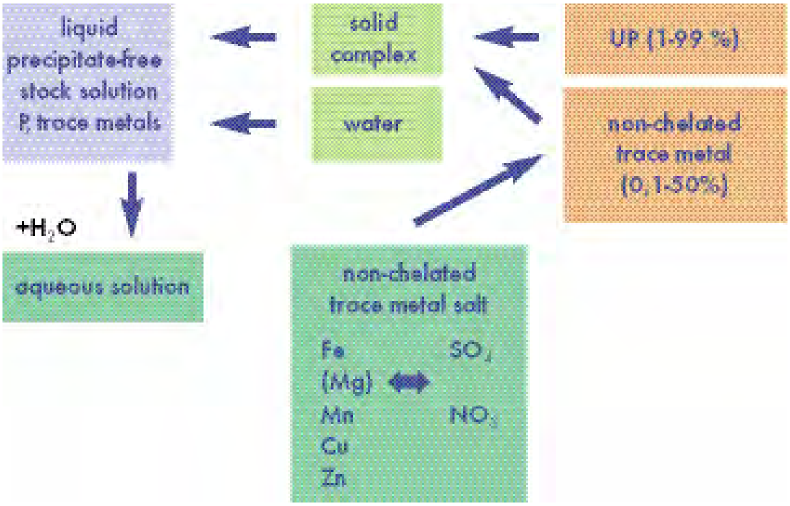


EP 569513.

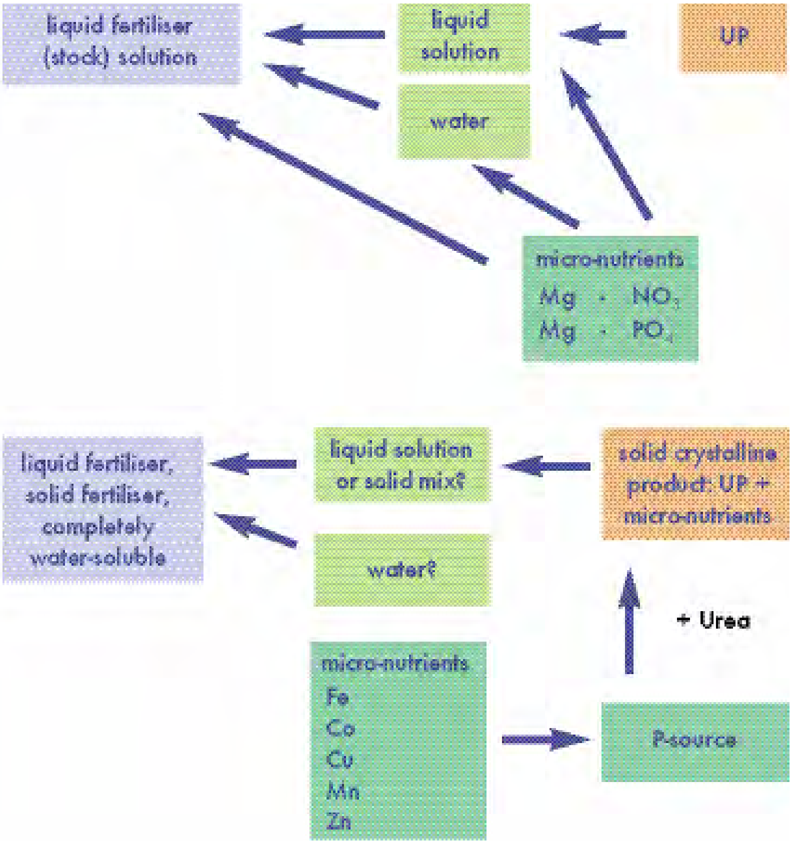


5.1.7 Schematic Overview of the Free Technology

EP 771774 APPLICATION REFUSED.

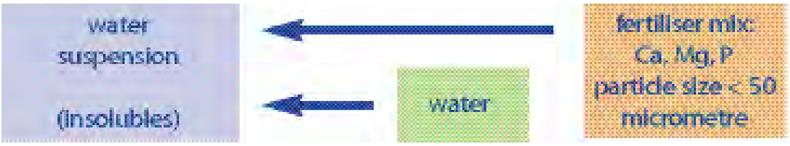


Patents lapsed (US 4013446 and US 3936501).

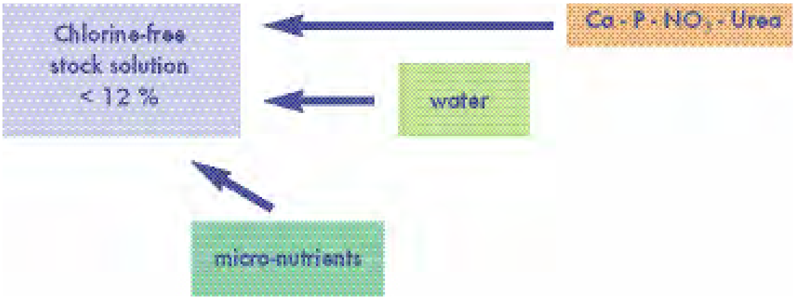


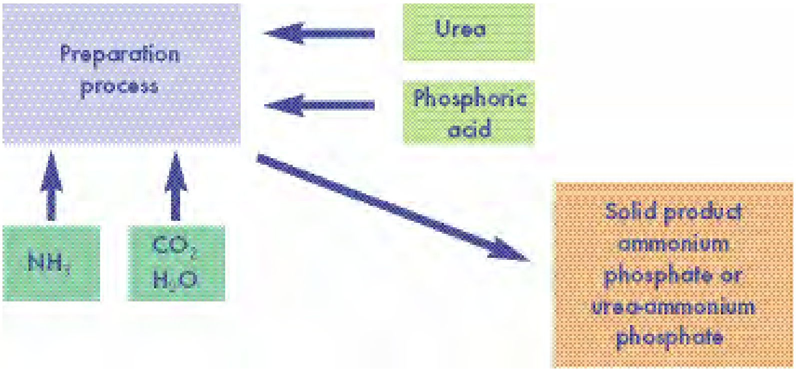
5.2 Schematic Overview of Kemira's Urea Phosphate Patents

Kemira: FI 98518. Difference in not being totally water-soluble.

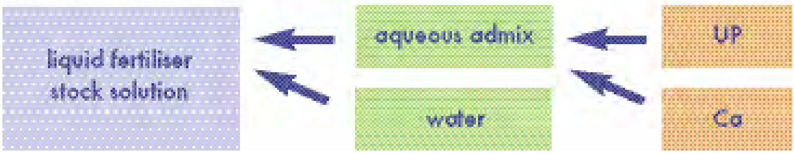


Kemira: FI 991460. Difference in including multiple ions in the same.

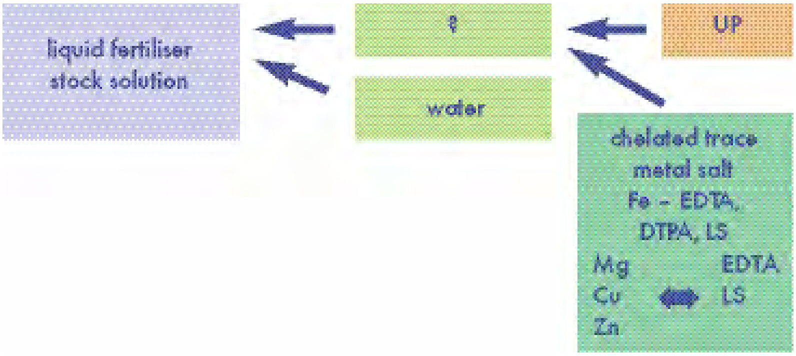




Kemira: FI 991563.



Other suggestions: Do not use dry solid mixtures, but use aqueous mixtures.



Other suggestions: Use of chelated trace metals without Ca.

5.3 Comprehensive Review of Urea Phosphate Patents

An executive summary of a "Comprehensive Review of Urea Phosphate Patents" is presented hereafter. This study was finished on Janua y 8, 2006.

One important update after the completion of this study took place on March 29, 2006, when the application of patent EP0771774 was refused. This patent was related to mixes of UP with trace elements. The rejection was published on 05/07/2006 (Annex 4). http://www.epoline.org/portal/public/registerplus.

5.3.1 Executive Summary

SQM contracted a company to conduct a comprehensive review of global patents regarding urea phosphate and to identify the "Patent Mine Fields" which might impact the use of urea phosphate in the arena of water-soluble fertilisers.

Public patent databases (US, Worldwide, EPO, WIPO, Canada, and Australia) were the sources of information for this study.

Although urea phosphate patent references number in the thousands, the most pertinent references with respect to WSFs are patents assigned to OMS Investments (Scotts-Miracle Gro), Kemira, and the Regents of the University of California.

5.3.1.1 Scotts-Miracle Gro

The Scotts patents are all from one inter-related patent family. They all stem from a single parent application (Inventors: Vetanovetz, Peters). The claimed subject matter deals with precipitate-free concentrated stock solutions, containing calcium and urea phosphate or with trace metal salts and urea phosphate or combinations of the three. The patents also claim methods for making the precipitate-free stock solutions and the dry fertiliser compositions (i.e. solid mixes of UP and a simple calcium salt and/or non-chelated trace metal salts) utilized in making precipitate-free concentrated stock solutions.

Patents have been issued in the United States, Canada, Australia, Turkey, Jordan and Europe (designated States). A Divisional Application (urea phosphate plus non-chelated trace metal salts) was refused in Europe.

The prosecution history of these cases involves numerous continuations, divisional and continuation-in-part applications. Each country is different in the breadth and content of the allowed claims. It is recommended that the "Claims Analysis and Review" section of this study be consulted to define the s ope of claims in each country.

Claims dealing with the solid fertilisers that are used to make the precipitate-free concentrated stock solutions are probably the easiest to police, as the infringing products would be most visible in the marketplace. Scotts has had a successful history of enforcing these patents against potential infringers. Infringers of the method claims and concentrated solutions claims would probably be end-users. However, the sellers of materials which may be used to make the concentrated solutions may bear a responsibility to inform customers of the existence of the patents. An attorney should be consulted on this matter.

Claimed coverage is quite broad in the US, Canada, Australia and Jordan. Coverage is more restrictive in Europe and Turkey. There may be opportunities to navigate around the claims, but this would require separate study and final confi mation by a patent attorney.

5.3.1.2 Kemira Agro Oy

Kemira was found to have two pertinent patent families dealing with the use of urea phosphate in water-soluble fertilisers.

The first stems from a Finnish patent application by Aijala which has granted claims in the United States, Latvia, South Africa and Morocco. It is pending in numerous countries including Europe. The granted claimed subject matter deals with stable calcium or magnesium containing aqueous suspensions which can be diluted with water to form working solutions. The suspensions must contain a phosphate ion (can be from urea phosphate, among others), at least one water-insoluble nutrient and a pH between 0,5-2. The method of forming the working solution is also claimed. Potential infringers of these claims are likely to be "end-users" and may not be highly visible. However, the providers of raw materials which may be used to make the claimed suspensions may bear a responsibility to inform customers of the existence of the patents. Again, an attorney should be consulted on this matter.

The second pertinent Kemira patent family is derived from a Finnish patent application by Weckman et al. It has been published in Finland, the PCT and in Australia. The PCT application designates essentially every country in the world as a designated state. The subject matter of the "pending claims" is a solid potassium nitrate product acidified with urea phosphate and aqueous solutions containing the solid, acidified potassium nitrate product. The solid acidified potassium nitrate product must contain 2%-15% urea phosphate and 85%-98% potassium nitrate. Other ingredients can be present. The patent application is deemed to be withdrawn (14.01.2005).

5.3.1.3 Regents of the University of California

The Regents of the University of California has two issued US Patents by Lovatt, which stem from a common parent application. The issued patents have numerous claims and it is suggested that the "Claims Analysis and Review" section of this study should be consulted in detail. In general, the claimed subject matter deals with concentrated phosphorous fertilisers (liquid or solid) which form fully solubilized use dilution fertilisers when diluted to 2,5% by weight or less in water. The concentrated phosphorous fertiliser must contain at least 30% by weight a phosphorous containing acid or salt. The patent specific tion does not specifically mention phosphoric acid (or salts, such as urea phosphate) but rather dwells on a group of phosphorous acids. However, a broad interpretation of the main claims would not preclude urea phosphate as one of the essential ingredients.

5.3.2 Objectives

Conduct a comprehensive review of "Urea-Phosphate" patents in accordance with the Project Proposal accepted November 28, 2005. Scope of Work to include:

A. Identific tion of Pertinent Patents (Patent Families)
   1) Filing status
   2) Legal status
   3) Expiration dates

B. Claims Review and Analysis
   1) What do claims restrict/what not
   2) Manufacturing limitations
   3) Calcium blending restrictions
   4) Non-chelated trace elements restrictions
      i. Restrictions on ferrous sulphate addition

5.3.3 Background

SQM recently purchased Kemira Emirates Fertilisers Company (Kefco) from Kemira and other shareholders. The purchase involves a production facility based in Dubai (United Arab Emirates). The facility produces urea phosphate using Kemira proprietary technology. Kefco has an annual capacity of 30.000 tonnes of high quality urea phosphate. SQM also acquired the rights to the technology and the brand name.

SQM has contracted a company to conduct a global patent review to expose the "Patent Mine Fields" regarding the use restrictions of urea phosphate in water soluble fertilisers.

5.3.4 Techniques & Procedures

The approach taken was to conduct searches on the public patent databases to identify the pertinent patents as well as the current status of the patents/applications. The following databases were employed in this study.

Worldwide: http://v3.espacenet.com/
Patent Abstracts of Japan
EP: http://v3.espacenet.com/
WIPO: http://v3.espacenet.com/
US: http://www.uspto.gov/
Canada: http://strategis.ic.gc.ca
Australia: http://www.ipaustralia.gov.au/

Patent documents (where available) were downloaded in PDF format and were used for the claims analysis. Copies of public patent documents are available on request.

5.3.5 Pertinent Patent Applications and Status

5.3.5.1 Scotts-Miracle Gro Company (OMS Investments)

A tabular summary of the Scotts Company patent applications (OMS Investments Inc.) is provided in Table 63.

Table 63. Summary of the Scott Company patent applications (OMS Investments Inc.).

Scott Urea Phosphate Patents

Application No.	Country	Filing Date	Priority Doc	Type Filing	Status	Patent Number	Publication Date	Expiration Date	Type Coverage	Ca Claims	Tr. Metal Claims
US 07/648,644	US	1/31/1991		Parent Case	Abandoned						
US 07/690,099	US	4/23/1991	US 07/648,644	CIP	Granted	5,171,349	12/15/1992	1/31/2011	Stock Solutions from dry UP	Yes	Yes
US 07/990,333	US	12/11/1992	US 07/648,644	CIP/Divisional	Granted	5,395,418	3/7/1995	12/15/2009	Method with dry solid admixtures	Yes	Yes
US 07/331,262	US	10/28/1994	US 07/648,644	CIP/Divisional	Granted	5,492,553	2/20/1996	1/28/2011	Dry solid unheated admixtures (unpolymerized UP)	Yes	Yes
US 07/167,677	US	12/15/1993	US 07/990,333	CIP/Divisional	Granted	5,454,850	10/3/1995	10/3/2012	Stock Solutions/Method of making with dry solid mixtures	Yes	No
PCT/US92/00850	WO	1/31/1992	US 07/648,644	International	National	WO	8/20/1992	1/31/2011			
92905776,8	EP	1/31/1992	US 07/648,644	PCT National	Granted	EP 0 569	11/12/1997	1/31/1997	Solid physical mix fertilizers and stock solutions	Yes	No
										Yes	No
AT19920905776T	AT	1/31/1992	US 07/648,644	EP National	Granted	AT160138	11/15/1997	1/31/2011	Same as EP513	Yes	No
92905776,8	BE	1/31/1992	US 07/648,644	EP National	Granted	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
92905776,8	CH	1/31/1992	US 07/648,644	EP National	Granted	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
DE19926023136	DE	1/31/1992	US 07/648,644	EP National	Granted	DE69223136	12/18/1997	1/31/2011	Same as EP513	Yes	No
929055776,8	DK	1/31/1992	US 07/648,644	EP National	Granted	DK569513T	4/27/2011	1/31/2011	Same as EP513	Yes	No
929055776,8	ES	1/31/1992	US 07/648,644	EP National	Granted	ES2109345	1/16/1998	1/31/2011	Method added	Yes	No
929055776,8	FR	1/31/1992	US 07/648,644	EP National	Granted	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
929055776,8	GB	1/31/1992	US 07/648,644	EP National	Granted	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
929055776,8	GR	1/31/1992	US 07/648,644	EP National	Granted	GR3025373	2/27/1998	1/31/2011	Same as EP513	Yes	No
929055776,8	IT	1/31/1992	US 07/648,644	EP National	Granted	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
929055776,8	LU	1/31/1992	US 07/648,644	EP National	Lapsed	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
929055776,8	MC	1/31/1992	US 07/648,644	EP National	Lapsed	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
929055776,8	NL	1/31/1992	US 07/648,644	EP National	Granted	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
929055776,8	SE	1/31/1992	US 07/648,644	EP National	Granted	569 513	11/12/1997	1/31/2011	Same as EP513	Yes	No
970200001,2	EP	1/31/1992	US 07/648,644	EP Divisional	Pending	771,774	5/7/1997		Solid complex fertilizers and stock solutions	No	Yes
13548/92	AU	1/31/1992	US 07/648,644	PCT National	Granted	663,306	10/5/1995	1/31/2011	Solid complex fertilizers and stock solutions	Yes	Yes
2,101,554	CA	1/31/1992	US 07/648,644	PCT National	Granted	2,101,554	4/16/2002	1/31/2011	Dry solid fertilizer for making stock solutions	Yes	No
2,345,952	CA	1/31/1992	US 07/648,644	CA Divisional	Granted	2,345,952	8/5/2002	1/31/2011	Dry solid fertilizer for making stock solutions	No	Yes
TR19920000110	TR	1/31/1992	US 07/648,644	National	Granted	28,925	8/5/1997	1/31/2011	Stock Solutions from dry UP	Yes	Yes
1695	JO	1/31/1991	US 07/648,644	National	Granted	1965	1/30/1992	1/31/2006	Solid complex fertilizers for making stock solutions	Yes	Yes

A history of each patent application (and the relationships between them) is discussed here below. Further details are provided in the sections on "Claims Review and Analysis".

U.S. Ser. No. 07/648,644

The Scotts patents are derived from the original U.S. Ser. No. 07/648,644 filed Jan. 31, 1991, now abandoned.

U.S. Ser. No. 07/690,099

The case was filed again (U.S. Ser. No. 07/690,099) on April 23, 1991 as a continuation-in-part of abandoned case 07/648,644. US Patent 5,171,349 issued on December 15, 1992.

U.S. Ser. No. 07/990,333

This case was filed as U.S. Ser. No. 07/990,333 on December 11, 1992 as continuation of Ser. No. 690,099, filed Apr. 23, 1991, now U.S. Pat. No. 5,171,349, which is a continuation-in-part of U.S. Ser. No. 07/648,644 filed Jan. 31, 1991, and now abandoned. The application issued as US Patent No. 5,395,418 on March 7, 1995

U.S. Ser. No. 07/331,262

The case was filed as U.S. Ser. No. 07/331,262 on October 28, 1994 as continuation of Ser. No. 07/989,398 abandoned, which is a continuation of Ser. No. 07/690,099, filed Apr. 23, 1991, now U.S. Pat. No. 5,171,349, which is a continuation-in-part of U.S. Ser. No. 07/648,644 filed Jan. 31, 1991, and now abandoned. The application issued of February 20, 1996 as US Patent No. 5,492,553.

U.S. Ser. No. 07/167,677

The case was filed as U.S. Ser. No. 07/167,677 on December 15, 1993. It is a continuation-in-part of application Ser. No. 07/989,398 filed Dec. 11, 1992, entitled SolubilityCompoundFertiliserCompositionsnowabandoned,andacontinuation–in-part application of Ser. No. 07/990,333, filed Dec. 11, 1992, entitled Solubility Compound Fertiliser Compositions now U.S. Pat. No. 5,395,418, which is a continuation of application Ser. No. 690,099, filed Apr. 23, 1991, now U.S. Pat. No. 5,171,349, entitled Solubility Compound Fertiliser Compositions, which is a continuation-in-part of application Ser. No. 648,644, filed Jan. 31, 1991, abandoned. The application issued as US Patent No. 5,454,850 on October 3, 1995.

PCT Application No. PCT/US92/00850

The case was filed as International Application No. PCT/US92/00850 on January 31, 1992. It is based upon the parent application; US Ser. No. 648,644, filed Jan. 31, 1991, abandoned. The following PCT member states were designated at the time of filing:
European Patent (Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, United Kingdom, Greece, Italy, Luxembourg, Monaco, the Netherlands, Sweden); Australia, Barbados, Bulgaria, Brazil, Canada, Switzerland, Finland, United Kingdom, Hungary, Japan, People's Republic of Korea, Republic of Korea, Sri Lanka, Madagascar, Malawi, Norway, Romania, Russian Federation, Sudan, Sweden.
The following countries were designated to be pursued into the National Phase: Europe, Canada, Australia.
The application was published on August 20, 1992 as WO 92/13813.

EPO Application No. EP19920905776.8

The case was filed as EPO Application No. EP19920905776.8. It is based upon International application number PCT/US92/00850 filed on January 31, 1992, which is based on the priority document: US Ser. No. 07/648,644, filed Jan. 31, 1991, abandoned. The following EP Contracting States were designated at the time of filing:
European Patent (Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, United Kingdom, Greece, Italy, Luxembourg, Monaco, the Netherlands, Sweden);
A Divisional Application EP1997 2000001.2 was filed on Janua y 3, 1997.
The amended original application was granted as European Patent No. EP0569513 on November 12, 1997 and was registered in all listed Contracting States. Coverage in Luxembourg and Monaco was allowed to lapse on February 16, 2000.

EPO Application No. EP1997 2000001.2

The case was filed as EPO Application No. EP1997 2000001.2 on January 3, 1997. It is a Divisional Application of EP19920905776.8, now European Patent No. EP0569513, which was based upon International application number PCT/US92/00850, filed on January 31, 1992 The following EP Contracting States have been designated:
European Patent (Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, United Kingdom, Greece, Italy, Luxembourg, Monaco, the Netherlands, Sweden);
The application was published as EP 0 771,774 A2 on May 7, 1997. The first examination report was issued on November 11, 1998. The application was refused.

Status:	The application has been refused Database last updated on: 09/03/2007
Most Recent Event:	02/06/2006 Refusal of application Published on 05/07/2006 [2006/27]
Applicant(s):	For all designated states OMS INVESTMENTS, Inc. 824 Market Street Mall Suite 102A Wilmington, Delaware 19801/ US [1997/19]
Inventor(s):	01 / Vetanovetz, Richard P. 2833 Pennsylvania Street Allentown, PA 18104 / US 02 / Peters, Robert 2833 Pennsylvania Street Allentown, PA 18104 / US [1997/26]
Representative(s):	Bentham, Stephen, et al J.A. KEMP & CO. 14 South Square Gray's Inn London WC1R5JJ / GB [2003/19]
Application No., Filing date:	97200001.2 31//01/1992 [1997/19]
Priority No., dates: Filing date:	US 19910648644 [1997/19] 31/01/1991
Filing language:	EN
Procedural language:	EN

Publication:	Type: A2 No.: EP0771774 Date: 07/05/1997 Language: EN [1997/19] Type: A3 No.: EP0771774 Date: 17/09/1997 [1997/38]	
Classific tion:	international: C05C9/00, C05B17/00, C05D9/02, C05G3/00, C05G5/00[1997/19]	
Designated Contracting States:	AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LI, LU, MC, NL, SE [1997/19]	
Title	German	Düngemittelzusammensetzungen mit verbesserter Löslichkeit [1997/19]
	English	Improved solubility compound fertiliser compositions [1997/19]
	French	Compositions d'engrais à solubilité améliorée [1997/19]
Application is treated	MUNICH/(+49-89) 23994465	
Examination procedure:	03/03/1998	Request for examination was made [1998/18]
	11/11/1998	Dispatch of examination report A.96(2), R.51 (2) (Time limit: M04)
	28/4/1999	Dispatchofcommunicationthattheapplicationisdeemed to be withdrawn, reason: A96(3)
	01/06/1999	Reply to examiniaton report
	01/06/1999	Fee for further processing A.121 paid
	01/06/1999	Request for further processing A.121 file
	17/06/1999	Decision on request for further processing A.121: request accepted
	18/01/2000	Request for accelerated examination file
	08/02/2000	Dispatch of examination report A.96(2), R.51(2) (Time limit: M06)
	17/08/2000	Reply to examination report

	01/08/2001	Dispatch of examination report A.96(2), R.51 (2) (Time limit: M03)
	26/10/2001	Reply to examination report
	05/09/2002	Date of oral proceedings
	15/10/2002	Dispatch of communication that the application is refused:, reason: A.97(1)
	12/03/2003	Minutes of the oral proceedings dispatched
	29/03/2006	Application refused, date of legal effect [2006/27]
Appeal(s) following examination:	13/12/2002	Appeal received No. T0316/03
	25/02/2003	Statement of Grounds file
	29/03/2006	Result of the Appeal Procedure: APPEAL OF APPLICANT REJECTED
	29/03/2006	Date of oral proceedings [2006/13]
	05/04/2006	Minutes of the oral proceedings dispatched [2006/14]
Parent application(s):	EP19920905776/EP0569513	
Fees Paid:	Renewal fee A.86	
	09/01/1997	Renewal fee patent year 03
	09/01/1997	Renewal fee patent year 04
	09/01/1997	Renewal fee patent year 05
	09/01/1997	Renewal fee patent year 06
	29/01/1998	Renewal fee patent year 07
	01/02/1999	Renewal fee patent year 08
	21/01/2000	Renewal fee patent year 09
	04/01/2001	Renewal fee patent year 10
	21/01/2002	Renewal fee patent year 11
	20/01/2003	Renewal fee patent year 12
	26/01/2004	Renewal fee patent year 13
	20/01/2005	Renewal fee patent year 14
	27/01/2006	Renewal fee patent year 15
Documents cited:	Search	[x] FR2235130 [A] FR2294641

Australian Application No. 13548/92

The case was filed as Australian Application No. 13548/92. It is based upon International application number PCT/US92/00850 filed on January 31, 1992, which is based on the priority document: Ser. No. 648,644, filed Jan. 31, 1991, abandoned. The amended original application was granted as Australian Patent No. 663,306 on October 5, 1995.

Canadian Patent Application No. 2,102,554

The case was filed as Canadian Application No. 2,102,554 on July 28, 1993. It is based upon International application number PCT/US92/00850 filed on January 31, 1992, which is based on the priority document: US Ser. No. 648,644, filed Jan. 31, 1991, abandoned. Canadian Patent No CA 2,101,554 was issued April 16, 2002.

Canadian Application No. 2,345,952

The case was filed as Canadian Application No. 2,345,952, and is a Divisional Application of Canadian Application No. 2101554, now Canadian Patent No. 210554. It is based upon International application number PCT/US92/00850 filed on January 31, 1992, which is based on the priority document: Ser. No. 648,644, filed Jan. 31, 1991, abandoned. Canadian Patent No CA 2,345,952 was issued Aug. 6, 2002.

Turkish Ser. No. TR19920000110

The case was filed in Turkey on January 31, 1992. It is based upon (U.S. Ser. No. 07/690,099), now US Patent No. 5,171,349 which was a continuation-in-part of abandoned case 07/648,644. Turkish Patent No. TR28925 issued on August 5, 1997.

Jordanian Application No. JO1695

The case was filed in Jordan on January 31, 1991. It is based upon (U.S. Ser. No. 07/648,644), now abandoned. Jordanian Patent No. 1695 issued on January 30, 1992.

5.3.5.2 Kemira Patents

A tabular summary of the pertinent Kemira patent applications is provided in Table 64. A history of each patent application (and the relationships between them) is discussed here below. Further details are provided in the sections on "Claims Review and Analysis".

Table 64. Summary of the pertinent Kemira patent applications for suspensions.

[illegible]											
Application No.	Country	Filing Date	Priority Data	Type Filing	Status	Patent Number	Publication Date	Expiration Date	Type Coverage	[illegible]	[illegible]
FI 953,155	FI	6/30/1995		Parent Case	Pending						
PCT/FI96/[illegible]	WO	6/28/1996	FI 953,155	International	National	WO/97/[illegible]	1/9/1997	6/30/2015	Suspensions	Yes	No
ES19960918717 ?	ES	6/28/1996	FI 953,155	PCT National	Published	ES2150[illegible]	10/1/2000	6/30/2015	Suspensions	Yes	No
19960918717	PT	6/28/1996	FI 953,155	PCT National	Published	[illegible]	1/31/2001	6/30/2015	Suspensions	Yes	No
	PL	6/28/1996	FI 953,155	PCT National	Published	324034	5/11/1998	6/30/2015	Suspensions	Yes	No
	AU	6/28/1996	FI 953,155	PCT National	Published	6[illegible]	1/23/1997	6/30/2015	Suspensions	Yes	No
US 08/[illegible]	US	3/30/1996	FI 953,155	PCT National	Granted	5,[illegible]	12/7/1999	6/30/2007	Suspensions	Yes	No
P-98 19	[illegible]	01/22/1998	FI 953,155	PCT National	Granted	[illegible]	11/23/1998	6/30/2015	Suspensions	Yes	No
ZA1996[illegible]	ZA		FI 953,155	National	Granted	ZA[illegible]	1/8/1997	6/30/2015	Suspensions	Yes	No
	MA		FI 953,155	National	Granted	23917	12/31/1997		Suspensions	Yes	No

PCT Application No. PCT/FI96/00360

The case was filed as PCT/FI96/00360 on June 20, 1996. It is based upon the priority application filed in Finland on June 22, 1995 (Finnish Application 953,155). It was published as PCT Publication WO97/00840 on January 9, 1997. The following states were designated:
Australia, Brazil, Belarus, Canada, China, Estonia, Hungary, Israel, Japan, Latvia, Lithuania, Mexico, Norway, New Zealand, Poland, Russia, Ukraine, United States, Europe.
Several of the designated states have also published the patent application:
Spain: Publication No. ES2150675T (December 1, 2000).
Portugal: Publication No. PT833806T (January 21, 2001).
Poland: Publication No. 324,224 (May 11, 1998).

US Application No. 08/981104

The case was filed as US Application No. 08/981104 on March 23, 1998 as a National Phase filing of PCT/FI96/00360. It is based upon the priority application filed in Finland on June 22, 1995 (Finnish Application 953,155). US Patent No. 5,997,602 issued of December 7, 1999.

Latvian Application No. P-98-10

The case was filed as Latvian Application No. P-98-10 on January 22, 1998 as a National Phase filing of PCT/FI96/00360. It is based upon the priority application filed in Finland on June 22, 1995 (Finnish Application 953,155). Latvian Patent No. LV 12071 issued of November 20, 1998.

South African Application No.

The case was filed as South African Application No. ?? on ?? as a direct national filin . It did not go through the PCT. It is based upon the priority application filed in Finland on June 22, 1995 (Finnish Application 953,155). South African Patent No. 9605220 issued of January 8, 1997.

Moroccan Application No.

The case was filed as Moroccan Application No. ?? on ?? as a direct national filin . It did not go through the PCT. It is based upon the priority application filed in Finland on June 22, 1995 (Finnish Application 953,155). Moroccan Patent No. 23917 issued of December 31, 1996.

PCT Application No. PCT/FI03/00026

The case was filed as PCT/FI03/00026 on January 15, 2003 (Table 65). It is based upon the priority application filed in Finland on January 15, 2002 (Finnish Application 20020070). It was published as PCT Publication WO 03/059845 on July 24, 2003. The following states were designated:

United Arab Emirates, Antigua and Barbuda, Albania, Armenia, Austria, Azerbaijan, Australia, Bosnia/Herzegovina, Barbados, Bulgaria, Belarus, Belize, Brazil, Canada, China, Switzerland, Columbia, Costa Rica, Cuba, Czech Republic, Germany, Denmark, Dominican Republic, Algeria, Ecuador, Spain, Estonia, Finland, Great Britain, Grenada, Georgia, Ghana, Gambia, Croatia, Hungary, Indonesia, Israel, India, Iceland, Japan, Kenya, Kyrgyzstan, Democratic Peoples Republic of Korea, Republic of Korea, Kazakhstan, Saint Lucia, Sri Lanka, Liberia, Lesotho, Latvia, Lithuania, Morocco, Republic of Moldova, Madagascar, Macedonia, Mongolia, Malawi, Mexico, Mozambique, Norway, New Zealand, Oman, Philippines, Poland, Portugal, Romania, Russia, Seychelles, Sudan, Sweden, Singapore, Slovakia, Sierra Leone, Tajikistan, Turkmenistan, Tunisia, Turkey, Trinidad/Tobago, Tanzania, Ukraine, Uganda, United States, Uzbekistan, Saint Vincent, Vietnam, Serbia/Montenegro, Zambia, Zimbabwe, ARIPO, Eurasian, Europe, OAPI.

Several of the designated states have also published the patent application:

Finland: Publication No. FI20020070 (July 16, 2003)

Australia: Publication No. 201,426 (July 16, 2003)

Status:	The application is deemed to be withdrawn Database last updated on: 12/03/2007	
Most Recent Event:	14/01/2005 PCT data prior to EPO publication 14/01/2005 Application deemed to be withdrawn published on 02/03/2005 [2005/09]	
Applicant(s):	For all designated states KEMIRA AGRO OY Porkkalankatu 3 00180 Helsinki / FI	
Inventor(s):	01 / WECKMAN, Anders Milkkeläntie 15 D 8 FIN-02770 Espoo / FI	
Application No., filing d te:	03700116,1 WO2003FI00026	15/01/2003
Priority No., dates:	FI20020000070	15/01/2002
Filing language:	FI	
Procedural language:	EN	
Publication:	Type: No.: WO03059845 Date: 24/07/2003 [2003/38]	
International search report:	Date: 24/07/2003 Authority: SE	
International search	international: C05C5/02, C05C9/00, C05C13/00	
Designated Contracting States:	AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LI, LU, MC, NL, PT, SE, SI, SK, TR	

Title	English	ACIDIC POTASSIUM NITRATE FOR IRRIGATION FERTILIZATION OF PLANTS
	French	NITRATE DE POTASSIUM ACIDE DESTINE A UNE FERTILISATION PAR IRRIGATION DE PLANTES
Application is treated in (/fax-nr)	THE HAGUE/(+31-70) 3403016	
Examination procedure:	01/08/2003	Request for preliminary examination filed nternational Preliminary Examination Authority: EP
	17/08/2004	Application deemed to be withdrawn, legal effect date [2005/09]
	21/09/2004	Dispatch of communication that the application is deemed to be withdrawn, reason: A.90 (3)/A.78(2)/R.15(2)/R.25 [2005/09]
Cited in	International search	[A] US4145208 [A] US5851260 [A] US5997602 [A] US6312493 [A] US4013446

Table 65. Summary of the pertinent Kemira patent applications for aqueous solutions and acidic KNO_3.

Kemira Urea Phosphate Patents											
Application No.	Country	Filing Date	Priority Doc.	Type Filing	Status	Patent Number	Publication Date	Expiration Date	Type Coverage	Co-Claims	To. Mined Claims
FI 20020070	FI	1/15/2002		Parent Case	Published	FI20020070	7/16/2003	1/15/2022	Aqueous Solutions and acidic KNO_3	No	No
PCT/FI03/00026 (*)	WO	1/15/2003	FI 20020070	International	Published	WO 03/059843	7/24/2003	1/15/2022	Aqueous Solutions and acidic KNO_3	No	No
AU2003201426	AU	1/15/2003	FI 20020070	PCT National	Published	AU2003201426	7/16/2003	1/15/2022	Aqueous Solutions and acidic KNO_3	No	No

(*) Most recent event: 14/01/2005 Application deemed to be withdrawn. Published on 02/03/2005 [2005/09].

5.3.5.3 Regents of the University of California Patents

A tabular summary of the pertinent University of California patent applications is provided in Table 66. A history of each patent application (and their interrelationships) is discussed here below. Further details are provided in the sections on "Claims Review and Analysis".

U.S. Ser. No. 08/642,574

This case was filed as U.S. Ser. No. 08/642,574 on May 3, 1996. It is a continuation of Ser. No. 08/192,508 (filed February 7, 1994) now US Patent No. 5,514,200. The application issued of November 3, 1998 as US Patent No. 5,830,255.

U.S. Ser. No. 08/642,574

This case was filed as U.S. Ser. No. 09/126,233 on July 30, 1998. It is a continuation application No. 08/642,574, (filed on May 3, 1996), now US Patent No. 5,830,255, which is a continuation of Ser. No. 08/192,508 (filed February 7, 1994) now US Patent No. 5,514,200. The application issued of November 3, 1998 as US Patent No. 5,830,255.

Table 66. Summary of the pertinent Kemira patent applications.

Regents of University of California											
Application No.	Country	Filing Date	Priority Doc	Type Filing	Status	Patent Number	Publication Date	Expiration Date	Type Coverage	Ca Claims	Tr. Metal Claims
08/642,574	US	5/3/1996	US 192,508	National	Granted	5,830,255	11/3/1998	2/7/2014	Concentration Phosphorous Fertilizer; Method of Applying Phosphorous to Plants	Yes	Yes
09/126,233	US	7/30/1998	US 192,508	National	Granted	6,113,665	9/5/2000	2/7/2014	Concentration Phosphorous Fertilizer; Method of Applying Phosphorous to Plants	Yes	Yes

Appendix 1:
Ultrasol™ Magnum Flex Concept

1 Introduction

Ultrasol™ Magnum Flex is a range of acidic, water-soluble NPKs with one formula per phenological stage. The absence of all other nutrients gives the farmer the fl xibility and freedom to decide if and how much he wants to put of magnesium, calcium and/ or trace elements.

Table A shows the phenological formulae of the Ultrasol™ Magnum Flex range. There are four different NPK formulae. The fi th formula is composed at the farmgate, when the farmer has to mix a nitrogen source (e.g. urea, ammonium nitrate) with Ultrasol™ Magnum Flex Flowering and Fruit Set.

Table A. The phenological formulae of the Ultrasol™ Magnum Flex range.

Ultrasol™ Magnum Flex formulae	Composition (N:P_2O_5:K_2O)
Ultrasol™ Magnum Flex Starter	16-30-15
Ultrasol™ Magnum Flex Flowering and Fruit Set + N source	30-8-15 based on Ultrasol™ Magnum Flex Flowering and Fruit Set : urea = 1:1, or based on Ultrasol™ Magnum Flex Flowering and Fruit Set : ammonium nitrate = 1:1,3
Ultrasol™ Magnum Flex Flowering and Fruit Set	15-15-30
Ultrasol™ Magnum Flex Production	14-7-39
Ultrasol™ Magnum Flex Multipurpose	16-22-23

2 Statements per Formula

In this chapter the statements per formula are presented, which refle t each formula's composition and key moment of use during the lifecycle of the plant.

2.1 Statement Ultrasol™ Magnum Flex Starter - NPK 16-30-15

Ultrasol™ Magnum Flex Starter is a formula which is high in phosphorous with $N:P_2O_5:K_2O$ = 1:2:1 ratio. This formula is designed to stimulate the sprouting and development of roots, stems and leaves, thanks to its nutrient balance and high phosphate content. It is used specifically during the first weeks of the vegetative cycle.

2.2 Statement Ultrasol™ Magnum Flex Flowering and Fruit Set + Nitrogen Source

This mix can be made by the farmer himself by simply adding a nitrogen fertiliser (e.g. urea, ammonium nitrate) to Ultrasol™ Magnum Flex Flowering and Fruit Set.

A mix of Ultrasol™ Magnum Flex Flowering and Fruit Set and urea at a ratio of 1:1 in the fertiliser tank, or a mix of Ultrasol™ Magnum™ Flex Flowering and Fruit Set and ammonium nitrate at a ratio of 1:1,3 in the fertiliser tank, will result in an NPK formula 30-8-15.

The resulting mix is high in nitrogen with $N:P_2O_5:K_2O$=4:1:2 ratio. This mix is designed for stages with a high requirement of nitrogen, especially during leaf expansion and vegetative growth. Ideal formula for leafy vegetables.

2.3 Statement Ultrasol™ Magnum Flex Flowering and Fruit Set - NPK 15-15-30

Ultrasol™ Magnum Flex Flowering and Fruit Set is a formula which is high in potassium with $N:P_2O_5:K_2O$ = 1:1:2 ratio. This formula is especially designed for one of the most intensive processes in the plant's life cycle: from fl wering to fruit formation, where potassium is responsible for the transport of the carbohydrates from the leaves to the reproductive organs (fruit, seed, tuber) in order to obtain more calibre, quality and weight. A key nutrient source in fl wer production. The relatively high phosphorous content makes this formula especially suitable for P-fixing soils. About 60% of the nitrogen is under the nitrate nitrogen form. A high nitrate nitrogen level acts synergistic in the uptake of potassium.

2.4 Statement Ultrasol™ Magnum Flex - Production NPK 14-7-39

Ultrasol™ Magnum Flex Production is a formula which is high in potassium with $N:P_2O_5:K_2O$ = 2:1:6 ratio. This formula is especially designed for the final phase in the plant's life cycle: from fruit formation to final harvest, where potassium is responsible for the transport of the carbohydrates from the leaves to the reproductive organs (fruit, seed, tuber) in order to obtain more calibre, quality and weight. About 80% of the nitrogen is under the nitrate nitrogen form. A high nitrate nitrogen level acts synergistic in the uptake of potassium. Frequently used when the irrigation water is saline with high levels of chloride. High nitrate levels are applied in the nutrient solution to counteract the negative effects of chloride excess imbalances.

2.5 Statement Ultrasol™ Magnum Flex Multipurpose -NPK 16-22-23

Ultrasol™ Magnum Flex Multipurpose is a multipurpose formula with $N:P_2O_5:K_2O$ = 2:3:3 ratio. The formula can be used in fertigation, pivot applications or for foliar applications in any stage of plant growth and development and can be used to correct nutritional deficiencies when it is difficul to identify the cause of the deficien y. The total nitrogen content is divided into 7% N-nitrate, and 9 % N-urea. The presence of urea facilitates the penetration and uptake of the other nutrients by the leaf, when applied as a foliar spray. Because Ultrasol™ Magnum Flex Multipurpose is a strong acidifie , it is highly recommended that the pH of the final tank mix is checked before application starts, as pH levels below 4 may provoke scorching.

3 Guidelines for Applications

Guidelines are presented for use in fertigation, pivot applications or for foliar applications.

3.1 Guidelines for Applications in Fertigation

Table B presents the composition of the product range and guidelines for applications in fertigation.

Table B. The composition of the product range and guidelines for applications in fertigation.

Phenological stage	Ultrasol™ Magnum Flex	Composition	Dose		
			gram/l	g/m²/day	kg/ha/day
Plant establishment	Starter	16-30-15	0,3-0,6	0,3-0,7	3-7
Leaf expansion and vegetative growth	Flowering and Fruit Set + N source	30-8-15	0,4-0,8	0,4-1,0	4-10
	Flowering and Fruit Set	15-15-30	0,2-0,4	0,2-0,5	2-5
	+ urea	46% N	0,2-0,4	0,2-0,5	2-5
	Flowering and Fruit Set	15-15-30	0,17-0,34	0,17-0,43	1,7-4,3
	+ ammonium nitrate	34% N	0,23-0,46	0,23-0,57	2,3-5,7
Flowering and fruit set	Flowering and Fruit Set	15-15-30	0,4-0,8	0,4-0,9	4-9
Reproductive stage	Production	14-7-39	0,3-1,0	0,8-1,2	8-12
Multipurpose	Multipurpose	16-22-23	0,4-1,0	0,6-1,2	6-12

If needed, additional nutrients can be applied with one of the products as suggested in Table C.

Table C. Solutions for additional nutrients need.

Additional need for	Suggested Product
Magnesium	Ultrasol™ Magnit
Magnesium	Ultrasol™ Magsul
Calcium	Ultrasol™ Calcium
Calcium and magnesium	Ultrasol™ Calmag
Trace element mix for fertigation	Ultrasol™ Micro Rexene® APN

3.2 Guidelines for Foliar Applications

The recommendation varies from solutions of 0,1-3% (0,1-3 kg/100 litres of spraying water), depending on crop, nutrient need, climate, soil type, moment of spraying, water quality and other components in the tank mix.

Because all NPK formulae are strong acidifier , it is highly recommended that the pH of the final tank mix is checked before application starts, as pH levels below 4 may provoke scorching.

Figure A. Foliar application.

3.3 Guidelines for Pivot Applications

Follow the local standard recommendations for similar NPK formulae.

Because all NPK formulae are strong acidifier , it is highly recommended that the pH of the final Pivot irrigation concentration is checked before application starts, as pH levels below 4 may provoke scorching.

Figure B. Pivot application.

4 Overview of Characteristics, Advantages and Benefit

Table D gives an overview of the characteristics, advantages and benefits of the Ultrasol™ Magnum Flex range.

Table D. An overview of the characteristics, advantages and benefits of the Ultrasol™ Magnum Flex range.

Characteristics	Advantages	Benefit
Dry, crystalline acid	Easy handling	Safe
Strong acid	Anti-clogging properties	Longer lifespan irrigation system
		Enables a good distribution of irrigation water and fertilisers
		Less work needed
		No additional acid needed
	Clear tank solutions	Less work needed to clean tanks
	Reduces pH of water and soil, which improves nutrient availability and nutrient uptake efficie y, and improves pesticide stability in foliar sprays	Higher yield and quality Less product needed, higher cost efficie y
	Improved water infilt ation and less sodium in calcareous sodic soils	Increased water use efficie y and less salt stress, resulting in higher yields
	Leading to earlier harvests (earliness)	Higher income, since market prices are higher in the early stage of harvesting
Double soil acidifying action	Less N volatilization under acid soil conditions	Increased nutrient and cost efficie y
Concentrated NPK range	Less product needed	Effici t
Pure	No risk of clogging or growth disturbances	Peace of mind
Highly soluble	Less water needed	Effici t
Fast dissolution	Less time needed	Effici t
Free fl wing crystals	No caking	Easy handling

Characteristics	Advantages	Benefit
NPKs containing urea	Urea promotes foliar uptake of other nutrients	Effici t
Complete NPK range per phenological phase for fertigation, foliar sprays and pivot	Convenience: only 1 formula needed per phenological phase	Effici t
Strong NPKs with at least 60 NPK units in total per formula	Allows for mixing with additional nutrients like nitrogen sources, calcium, magnesium and trace elements	Flexibility

5 Benchmarking with Standard NPKs Containing Mg and TE

Ultrasol™ Magnum Flex is a range of acidic, water-soluble NPKs, contrary to standard water soluble NPKs that lack acidity. Suffici t acidity keeps the drip irrigation system clean, improves nutrient availability in the soil and the uptake by the plant, which results in higher yield and quality, and consequently higher farmer's income.

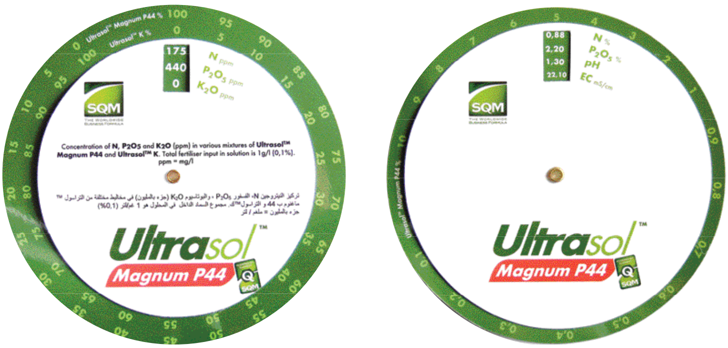
The absence of all other nutrients gives the farmer the fl xibility and the freedom to decide if and how much he wants to apply of magnesium, calcium and/or trace elements. This fl xibility doesn't exist with standard NPKs, which may lead to imbalanced plant nutrition or to paying for something the plant does not need.

Ultrasol™ Magnum Flex is a highly concentrated NPK range with at least a total of 60 nutrients ($N+P_2O_5+K_2O$) per formula, whereas other formulae may be less concentrated, because of the use of sulphate based raw materials.

Appendix 2: Ultrasol™ Magnum P44 Disk

1 Introduction

This Appendix describes the advantages and benefits of the Ultrasol™ Magnum P44 disk and explains how the disk should be used. Examples of the calculations are provided to illustrate the reasoning behind the disk and to demonstrate its practical use.



2 Advantages and Benefits of th Ultrasol™ Magnum P44 Disk

This The Ultrasol™ Magnum P44 disk is a tool that explains to farmers and dealers, how they can fulfil the plant's need of P and K and a major part of N during the growing season, by mixing only two of the highest quality specialty plant nutrition products, being Ultrasol™ Magnum P44 and Ultrasol™ K.

With this tool a fertilisation programme can be built from rooting stage until harvesting stage, simply by turning the disk in the right position for every growth stage:

- High P during the stage of root formation and plant establishment.
- Balanced NPK ratio during fruit set.
- High K during fruiting and harvesting.

With this simple mixing tool, the farmers ensure:

- Using high quality plant nutrition products in the fertiliser tank.
- Having: acidic fertigation solution all the season, clean drip irrigation, acidic soil solution, increased nutrient availability, high root performance, no need for liquid acids, among other advantages. For an extensive overview of the advantages of Ultrasol™ Magnum P44 see Chapter 3.
- Having the fl xibility to change the formula based on the plant's performance and growth stage, while the tool allows to apply extra N if needed.
- Ensuring having 99,8 % soluble P, whereas the K source is Ultrasol™ K.
- The mixture is virtually free of Na, Cl, sulphate and heavy metals.
- That they buy N, P, K and Acid in one powder mixture.
- That they can use Ultrasol™ Magnum P44 during all the season and not just as a starter or fl wering formula.

Hint: use pH indicator strips to show the pH drop in irrigation water after the addition of the acidic mix of Ultrasol™ Magnum P44 and Ultrasol™ K in comparison to mixes based on MAP or MKP as the P source.

The target users for the Ultrasol™ Magnum P44 disk are:

- Small dealers – to make blends on spot or as a sales support tool.
- Farmers who are shifting to straight fertilisers.
- Farmers, using ppm to base their fertigation programme on.

3 How to Use the Disk

This disk has a dual purpose with different mixing tables on both sides.

Side 1

Figure A gives the % of N, the % of P_2O_5, the pH level and the EC (mS/cm) at different concentrations (%) of Ultrasol™ Magnum P44, after it is dissolved in water with an initial pH 7. When 1% of Ultrasol™ Magnum P44 is dissolved in water, then 0,18% N and 0,44% P_2O_5 are applied.

Side 1 - Example 1

After dissolving 1 kg of Ultrasol™ Magnum P44 in 100 litres of water (1% solution), the solution will contain 0,18 kg (180 g) N and 0,44 kg (440 grams) P_2O_5. The pH of the solution drops from 7 to 1,71, while the EC value will be 6,6 mS/cm.

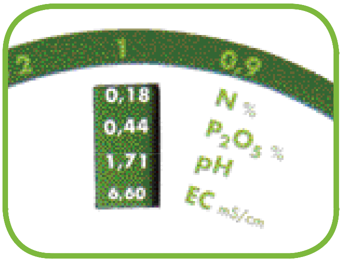


Figure A. When 1% (10 grams per litre) of Ultrasol™ Magnum P44 is dissolved in water, then 0,18% N and 0,44% P_2O_5 are applied. The pH of the solution drops from 7 to 1,71, while the EC value will be 6,6 mS/cm.

Side 1 - Example 2

After dissolving 5 kg of Ultrasol™ Magnum P44 in 100 litres of water (5% solution), the solution will contain 0,88 kg (880 g) N and 2,2 kg (2.200 grams) P_2O_5. The pH of the solution drops from 7 to 1,3, while the EC value will be 22,1 mS/cm.

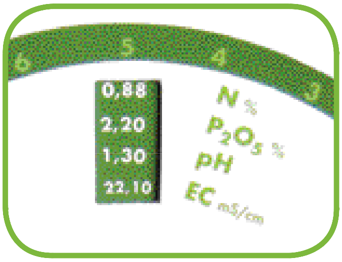


Figure B. When 5% (50 grams per litre) of Ultrasol™ Magnum P44 is dissolved in water, then 0,88% N and 2,20 % P_2O_5 are applied. The pH of the solution drops from 7 to 1,3, while the EC value will be 22,10 mS/cm.

Side 2

Figure C indicates how a water-soluble NPK recipe per growth stage can be made by mixing Ultrasol™ Magnum P44 and Ultrasol™ K in different ratios in order to get the desired amounts of N, P_2O_5 and K_2O (in ppm) in the fertigation programme.

Figure C. Indication of how a water-soluble NPK recipe per growth stage can be made by mixing Ultrasol™ Magnum P44 and Ultrasol™ K in different ratios in order to get the desired amounts of N, P_2O_5 and K_2O (in ppm) in the fertigation programme.

Side 2 - Example 1

Mixing 30 kg of Ultrasol™ Magnum P44 with 70 kg of Ultrasol™ K will result in getting a 15-13-32 ws NPK formula. If 1 gram of this 15-13-32 ws NPK formula is dissolved in 1 litre of water, then the solution will contain 147 ppm N, 132 ppm P_2O_5 and 319 ppm K_2O (Figure D).

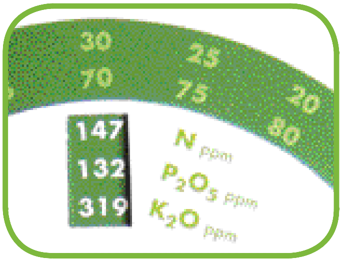


Figure D. Mixing 30 kg of Ultrasol™ Magnum P44 with 70 kg of Ultrasol™ K will result in getting a 15-13-32 ws NPK formula. If 1 gram of this 15-13-32 ws NPK formula is dissolved in 1 litre of water, then the solution will contain 147 ppm N, 132 ppm P_2O_5 and 319 ppm K_2O.

Side 2 - Example 2

Mixing 70 kg of Ultrasol™ Magnum P44 with 30 kg of Ultrasol™ K will result in getting a 16-31-14 ws NPK formula. If 1 gram of this 16-31-14 ws NPK formula is dissolved in 1 litre of water, then the solution will contain 163 ppm N, 308 ppm P_2O_5 and 137 ppm K_2O (Figure E).

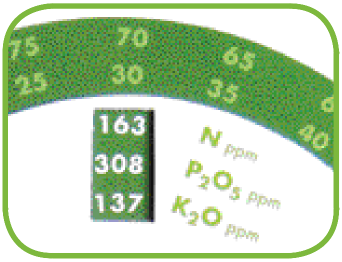


Figure E. Mixing 70 kg of Ultrasol™ Magnum P44 with 30 kg of Ultrasol™ K will result in getting a 16-31-14 ws NPK formula. If 1 gram of this 16-31-14 ws NPK formula is dissolved in 1 litre of water, then the solution will contain 163 ppm N, 308 ppm P_2O_5 and 137 ppm K_2O.

Turn the wheel during the season to prepare optimum recipe based on growth stage (Table A, Figure F), starting at a high P level in the beginning, and ending at a high K level during the final rowth phase.

Table A. Possible mixing ratios for certain growth stages.

Step	Growth stage *,**	Mixing ratio (%)	
		Ultrasol™ Magnum P44	Ultrasol™ K
1	Start wk 1-2	100	0
2	Start wk 3-4	80	20
3	Flowering and fruit set	50	50
4	After fruit set	35	65
5	Harvesting	10	90

* It is highly recommended to perform soil, water and/or plant analysis on a regular basis in order to make the most effici t plant nutrition recommendation.

** In case of high N demand, it is recommended to apply an additional N fertiliser during the growth stage.

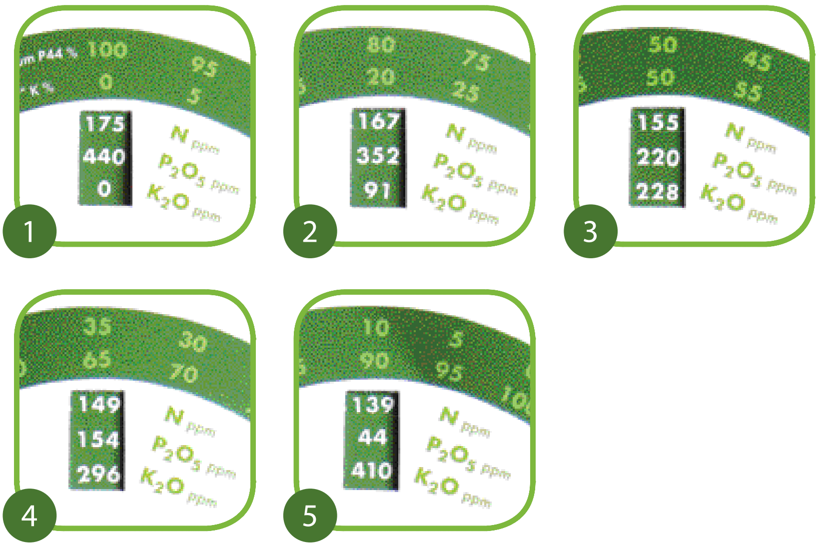


Figure F. Turn the wheel during the season to prepare optimum recipe based on growth stage. The fi e different mixing ratios 1-5 correspond with different crop needs during each phenological phase.

Calculations

In case of mixing 30 kg Ultrasol™ Magnum P44 with 70 kg of Ultrasol™ K:

P_2O_5	= 30 kg * 44,0% =	13,2 kg P_2O_5	
K_2O	= 70 kg * 45,5% =	31,9 kg K_2O	
N:			
From Ultrasol™ Magnum P44	= 30 * 17,5%	=	5,25 kg N
From Ultrasol™ K	= 70 * 13,5%	=	9,45 kg N
Total N		=	14,70 kg N

This mix of 30 kg Ultrasol™ Magnum P44 with 70 kg of Ultrasol™ K results in a water soluble NPK formula of 15-13-32.

Expressed in ppm, the calculation goes as follows:

30 kg of Ultrasol™ Magnum P44 contains = 30*0,44 = 13,2 kg P2O5 or 13.200.000 mg P_2O_5.

When adding 13.200.000 mg P_2O_5/100 litres of water = 132.000 mg P_2O_5/litre of water in the tank.

Input solution at 0,1% (or 1 gram per litre)
= 132.000 mg P_2O_5 * (0,1%/100%) = 132 mg P_2O_5/ litre = 132 ppm P_2O_5

A similar calculation is valid for K and N.

Table B shows the amounts of N, P_2O_5 and K_2O (in ppm) at certain mixing ratios of Ultrasol™ Magnum P44 with Ultrasol™ K.

Turn the wheel during the season to prepare optimum recipe based on growth stage (Table A, Figure F), starting at a high P level in the beginning, and ending at a high K level during the final rowth phase.

Table B. Possible mixing ratios for certain growth stages.

Ultrasol™ Magnum P44 %	Ultrasol™ K %	N ppm	P_2O_5 ppm	K_2O ppm
0	100	135	0	455
5	95	137	22	432
10	90	139	44	410
15	85	141	66	387
20	80	143	88	364
25	75	145	110	341
30	70	147	132	319
35	65	149	154	296
40	60	151	176	273
45	55	153	198	250
50	50	155	220	228
55	45	157	242	205
60	40	159	264	182
65	35	161	286	159
70	30	163	308	137
75	25	165	330	114
80	20	167	352	91
85	15	169	374	68
90	10	171	396	46
95	5	173	418	23
100	0	175	440	0

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