International Conference on Enhanced-Efficiency Fertilizers

An IFA-New Ag International Event
23-24 March 2010
Hotel Hyatt Regency, Miami, FL, USA

NITRIFICATION INHIBITORS AND THE IMPACT OF THEIR USE, WITH SPECIAL REFERENCE TO FERTIGATION

Georg EBERT
COMPO EXPERT, Germany

International Fertilizer Industry Association

NEW AG INTERNATIONAL

COMPO EXPERT

EXPERTS FOR GROWTH

Nitrification inhibitors and the impact of their use, with special reference to fertigation

IFA/NewAG Miami
23 March 2010

Georg Ebert, COMPO EXPERT, Münster

COMPO EXPERT

EXPERTS FOR GROWTH

Agenda

- Nitrification inhibitors
- DMPP - Mode of action
- Environmental effects
  - Gaseous N losses
  - NO_3 leaching
- Physiological effects of NH_4
- Effect on crop yield and quality
- Summary

www.compo-expert.de

COMPO EXPERT

EXPERTS FOR GROWTH

Nitrification inhibitors

DCD	Dicyandiamide	(Europe)
Nitrapyrin (N-Serve)	2-chloro-6-(trichloromethyl)-pyridine	(US)
DMPP	3,4-dimethylpyrazol-phosphate	

Heterocyclic N compounds
S compounds
Urea derivates
Acetylene derivates
Ammonium thiosulfate
…..

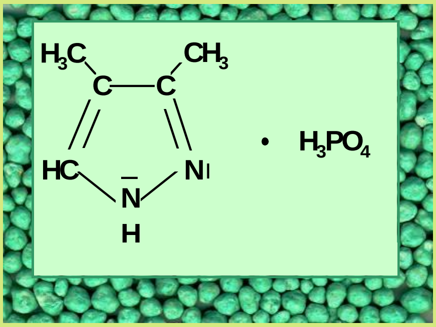
www.compo-expert.de

COMPO EXPERT

EXPERTS FOR GROWTH

DMPP

DMPP = Dimethylpyrazolephosphate



- BASF development (1994 - 1999)
- Derived from the group of pyrazoles
- Highly effective even at low application rates
- Breakdown depending on temperature
- Not present in harvested goods or other residues
- Highly specific for Nitrosomones
- Bacteriostatic, not bactericide

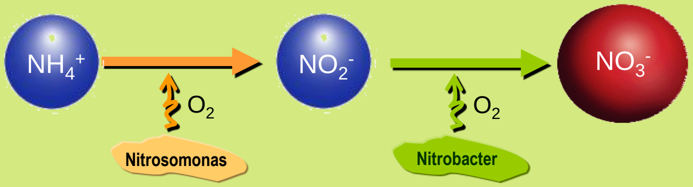
CAS-Nr.:	202842-98-6
form:	powder
colour:	white to grey
pH:	2.5 – 3,0 (132 g/l, 25° C)
melting point:	approx 165° C
density:	1.51 g/cm³
solubility:	132 g/l, 25° C (water)
log Pow:	1.26

www.compo-expert.de

COMPO EXPERT

EXPERTS FOR GROWTH

DMPP – Mode of action

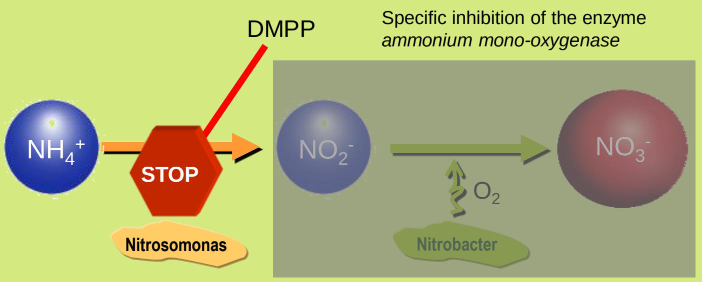


www.compo-expert.de

COMPO EXPERT

EXPERTS FOR GROWTH

DMPP – Mode of action

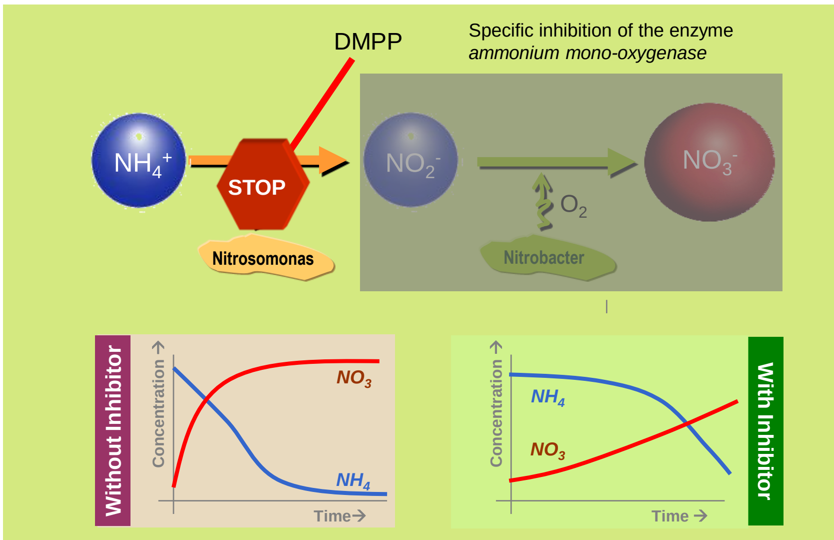


www.compo-expert.de

COMPO EXPERT

EXPERTS FOR GROWTH

DMPP – Mode of action



www.compo-expert.de

COMPO EXPERT

EXPERTS FOR GROWTH

Gaseous N losses

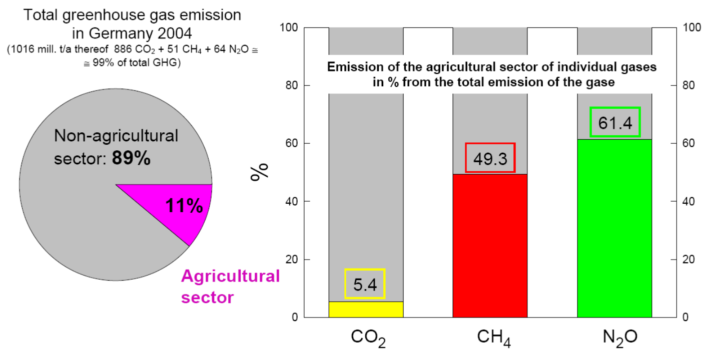
Environmental effects

Gaseous N losses

NO_3 leaching

Contribution of the agricultural sector on greenhouse gas emissions in Germany

all data expressed as CO_2 equivalents



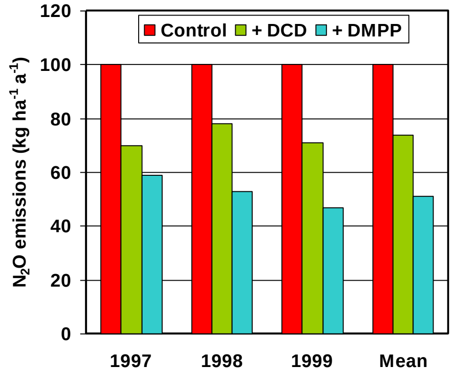
Data from Wegener *et al.* (2006) Agricultural Engineering Research 12, 103-114

www.compo-expert.de

N_2O Emissions from agricultural land

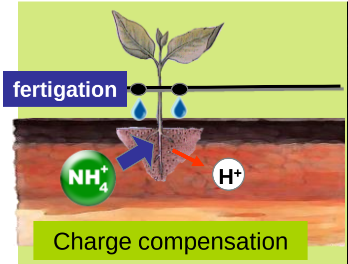
Influence of DMPP on N_2O emissions (denitrification)

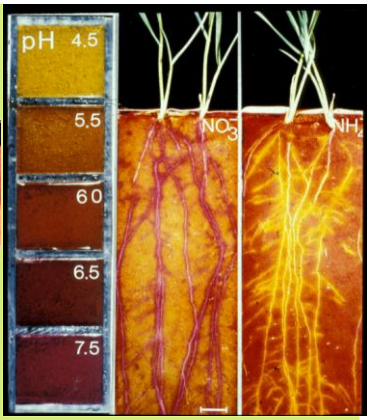
3-years field trials in Germany



From: Weiske, Benckiser, Herbert and Ottow. Biol Fertil Soils (2001) 34:109–117

Physiological effects of NH_4





Prevailing NH_4-absorption leads to acidification of the rhizosphere

Prevailing NO_3-absorption leads to alkalinization

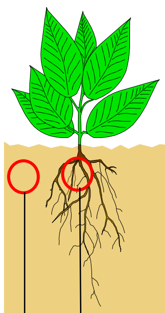
Photo: Römheld, University of Hohenheim, Germany

COMPO EXPERT

EXPERTS FOR GROWTH

N form and nitrification inhibitor improve trace element uptake from the soil

(Trials with beans, sandy loam, P source: rock phosphate)



N-form	pH-value Far from roots	pH-value Rhizo-sphere	Nutrient absorption (µg/m root length) P	Fe	Mn	Zn	Cu	K
NO_3	**6.6**	**6.6**	**123**	**55**	**8**	**7**	**1.4**	**903**
NH_4	**5.7**	**5.6**	**342**	**71**	**20**	**13**	**2.0**	**1127**
NH_4 + NI	**6.6**	**4.5**	**586**	**166**	**35**	**19**	**4.6**	**1080**

Ammonium nutrition: Rhizosphere effect due to increased cation absorption

Acidification due to ammonium fertilization

$NH_4^+ + 2\ O_2 \rightarrow NO_3^- + H_2O + 2\ H^+$

www.compo-expert.de

From: Thomson et al. (1993) J. Plant Nutr. 16, 493-506

COMPO EXPERT

EXPERTS FOR GROWTH

NH_4-N improves cytokinin and flower bud formation in apple trees

Shoot growth, flower induction and cytokinins in xylem exudate of apple root stock M7 as affected by the form of N supply

Form of N-supply	Shoot length [cm]	No. lateral shoot (spurs)	Flowering buds [% of emerged]	Cytokinins [nmol/100 g shoot fresh wt]
NO_3-N	326	6.4	7.4	0.002
NH_4NO_3	268	6.0	8.2	0.373
NH_4-N	209	8.9	20.7	0.830

www.compo-expert.de

From: Gao et al. (1992) J. Amer. Soc. Hort. Sci. 117, 446-4

COMPO EXPERT

EXPERTS FOR GROWTH

Summary of physiological effects

- More balanced NH_4 to NO_3 supply to roots
  - A more balanced cation to anion uptake by the plant
    ⇒ less spending of metabolic energy for nutrient uptake
  - The NH_4 part of N uptake is already reduced
    ⇒ no metabolic energy ($NADH_2$) needed for reduction
  - Positive effects on phytohormones (*e.g.* cytokinines) and polyamine metabolism (reasonable presumptions)
- Relative acidification of the rhizosphere compared with the bulk soil ⇒ enhanced availability of nutrients

COMPO EXPERT

EXPERTS FOR GROWTH

Effect on crop yield and quality

^{15}N Trials in Citrus Trees

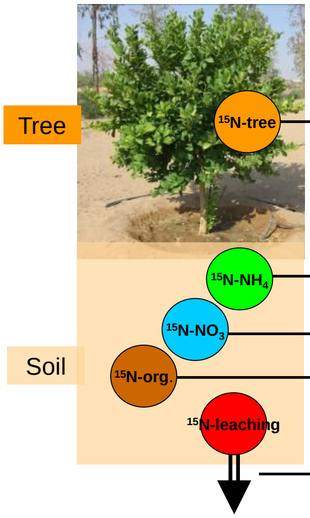
Trials on Melon produced in greenhouse

COMPO EXPERT

Nitrogen Efficiency in Citrus using ^{15}N

Distribution of ^{15}N after application of NH_4NO_3 alone or along with DMPP

Fertigation frequency: **30 days per month**



	NH_4NO_3	NH_4NO_3 + DMPP
N-Tree	22%	30%
NH_4-N	2%	6%
NO_3-N	52%	44%
Org.-N	10%	12%
N-Losses	14%	8%

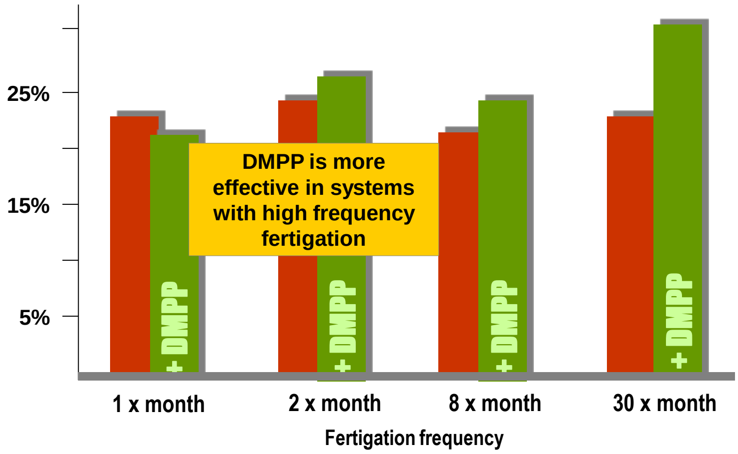
www.compo-expert.de

In cooperation with the Valencia Institute of Agronomic Research (Spain)

COMPO EXPERT

Nitrogen Efficiency in Citrus using ^{15}N

N use efficiency related to fertigation frequency



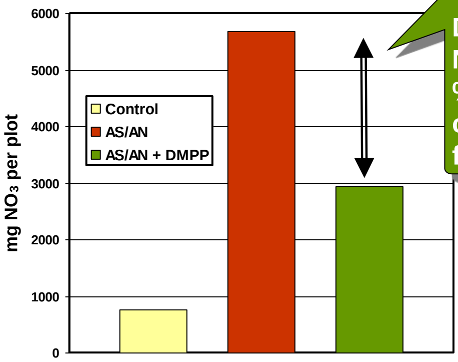
www.compo-expert.de

COMPO EXPERT

Reduction of N losses in an orange fertigation system

(Trials in Valencia, Spain 1999. Fertigation every 20 days using $(NH_4)_2SO_4$ (AS) + NH_4NO_3 (AN), total:12 g N per tree)

N found in drainage water



The use of DMPP reduces N-losses by 50 % compared to conventional fertilization

www.compo-expert.de

COMPO EXPERT

Yield increase in clementine trees

(Trials at I.V.I.A, Valencia, Spain, 1998-2001,
500 trees/ha; 400 g N/tree; AS + DMPP 0.5%)

	AS 4x per week	+ DMPP	AS 2x per week	+ DMPP	AS 1x per week	+ DMPP
Kg/tree	64	70	69	75	63	70
Fruit weight	103.4	100.0	97.9	97.7	102.3	98.2
No of fruits per tree	618	706	704	777	635	716

www.compo-expert.de

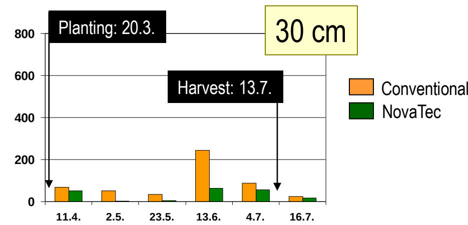
COMPO EXPERT

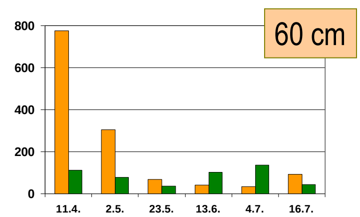
EXPERTS FOR GROWTH

Optimization of N fertigation in melon

NO_3 concentration (mg/l) in soil solution at 30 cm and 60 cm soil depth

Crop: Melon, “Piel de Sapo”, planted 2 x 1.3m
Duration: 115 days, daily irrigation
Soil: pH 8.6, 23% active $CaCO_3$,
low organic matter, slightly saline





In cooperation with CIFACITA Research Institute. Murcia, Spain

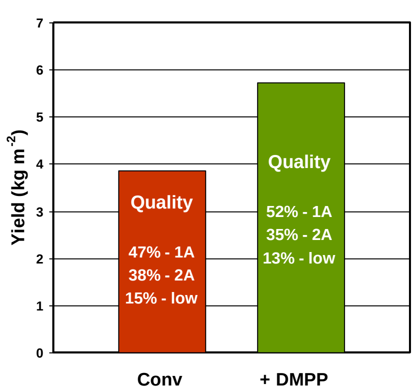
www.compo-expert.de

COMPO EXPERT

EXPERTS FOR GROWTH

Optimization of N fertigation in melon

Higher fruit yield and more “high quality” fruits

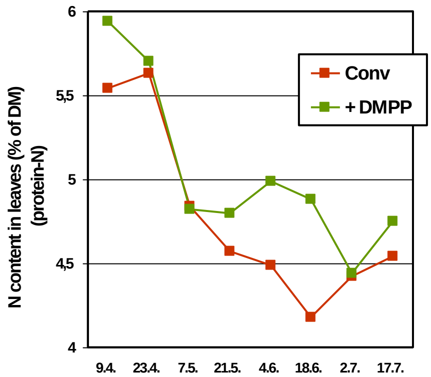


www.compo-expert.de

COMPO EXPERT

Optimization of N fertigation in melon

Higher N uptake effciency

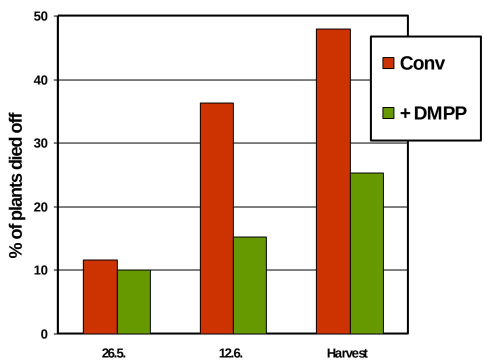


www.compo-expert.de

COMPO EXPERT

Optimization of N fertigation in melon

Plants survived high temperature periods and showed resistance to "Melon collapse" caused by the fungus *Acremonium sp.* due to better root growth



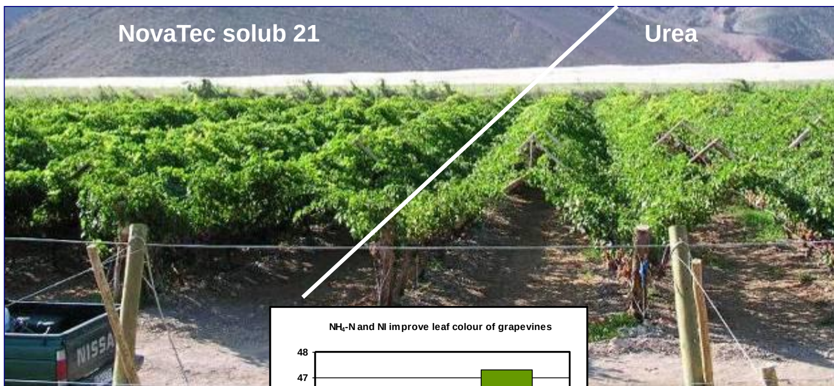
Www.compo-expert.de

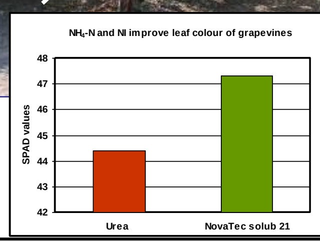
COMPO EXPERT

EXPERTS FOR GROWTH

Effect of NovaTec21 on table grape canopy

Cv. “Red Globe”, sandy soil
Copiapó, Río Blanco Export, Chile, 2005



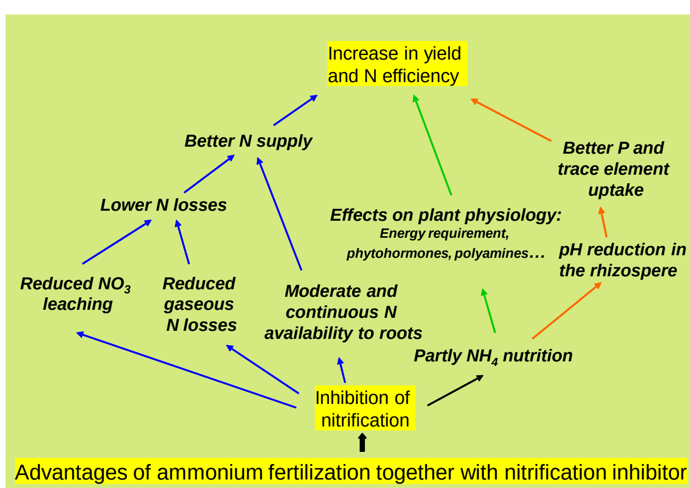


www.compo-expert.de

COMPO EXPERT

EXPERTS FOR GROWTH

Summary



www.compo-expert.de