



Is there a need to apply chloride-free fertilizer to the chloride sensitive red currant (*Ribes rubrum* L.) under West European climate conditions?



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■ Introduction

In most Plant Nutrition text books it is mentioned that chloride sensitive crops such as red currant (*Ribes rubrum* L.) should get fertilized with chloride-free fertilizers (e.g. Marschner, 1995)

or

chloride-containing fertilizers should get applied in autumn to guarantee adequate chloride leaching during the rainy winter period (e.g. Mengel and Kirkby, 1994?)



In an intensive literature search we could not find any experimental proof for both above made statements;

thus, the objective of the reported research was to prove both statements by different experimental approaches:

- short term nutrient solution experiments,
- pot experiments in a greenhouse with 12 cultivars,
- long term field experiments with 5 different red currant cultivars and strawberries and a
- model soil column experiment on chloride leaching under field conditions



■ Experimental approaches

Low NaCl application rate refers to

NaCl in “Korn-Kali” or “40er Kali”

High NaCl application rate refers to

NaCl in “Kali-Rohsalz” or 6% K fertilizer





Long-term pot experiment with 12 cultivars of red currant and black currant in a greenhouse at Hohenheim





Soil and leaf sampling at
the experimental station at
Bavendorf (near Lake of
Konstanz)





Two field sites with strawberries for measurement of chloride leaching
A. Wittlaerer Hof, Düsseldorf, **B.** Korb, Southwest Germany.





Soil columns located under field conditions at the Wittlaerer Hof, Düsseldorf to measure chloride leaching over the winter period





First fruit set in 2003 at Bavendorf for measurement of choride and cadmium in the fruit press sap.



■ Selected results

- _ Adequate chloride leaching during the winter period?
- _ Can be avoided, a chloride accumulation in leaves and fruit press sap at autumn application?
- _ Is there an effect of NaCl, particularly at spring application, on mobilization of cadmium?



Adequate chloride leaching during the winter period?

Average chloride concentration in the soil (mg Cl / kg soil)* of 5 cultivars** in different soil depths depending on the date of NaCl application (Autumn versus spring)*** “Long-term field experiment”

Soil depth (cm)	High application rate	
	Autumn 2002	Spring 2002
0-15	12	<u>416</u>
15-30	68	56
30-45	<u>219</u>	60
45-60	146	46

* Detection limit: <6.0 mg Cl / kg soil

** Average of cultivars: *Rolan: Red Lake, Titania, Tenah, Weiße Langtr.*

*** Application date 8. Nov. 2002 or 4. April. 2003; Soli sampling 9. May. 2003

At autumn application most chloride was already below 30 cm; whereas at spring application still most chloride was in the top 0 – 15 cm layer!



Chloride leaching in two strawberries fields!

Chloride concentration in two different soil depths of a strawberry field (mg Cl / kg soil) at Wittlaer Hof (A) and Korb (B) “Field experiment”

Soil depth (cm)	Application in Autumn							Application in Spring					
	-----Dates of soil sampling-----												
(A)	----15.12.97----			-----12.03.98----				----19.06.98---			----19.06.98----		
0-25	4.8	38.7	98.0	34.5	12.1	15.2	n.d.*	6.7	8.8	3.3	19.2	34.9	
25-50	8.9	13.8	23.7	25.1	22.7	48.7	n.d.	6.1	13.7	3.2	22.2	55.7	
(B)	-----12.12.97----			-----06.03.98----				-----05.06.98----			-----05.06.98----		
0-25	10.5	28.3	80.9	2.9	n.d.	8.8	n.d.	10.2	10.8	10.0	12.8	62.1	
25-50	-----not sampled-----												

* n.d. = not detectable

At autumn application of NaCl the chloride concentration in both soil layers was much lower (factor 4-5) than at the spring application! This was the case for both sites.



Chloride leaching in soil columns under field conditions!

Chloride concentration (mg Cl / kg soil) in 4 depths of soil columns loaded with three NaCl rates (0.3, 0.6, 1.8 g NaCl per column) after leaching during winter period (total of 516 mm rain) “Soil column experiment”

Soil depth (cm)	0.3g NaCl	0.6g NaCl	1.8g NaCl
0-10	n.d.*	n.d.	n.d.
10-20	n.d.	n.d.	15.1
20-30	2.3	7.2	44.1
30-40	4.8	15.5	104.2
Total leaching rate(%)	<u>97.5</u>	<u>95.6</u>	<u>90.1</u>

* n.d. = not detectable

During winter period under field conditions more than 90% of the applied NaCl at autumn was leached below 40 cm!



Can be avoided, a chloride accumulation in leaves and fruit press saps at autumn application?

Average chloride concentration in leaves (mg Cl / g dry wt) of 5 cultivars* depending on application rate and date of NaCl
“Long-term field experiment“

Year	Control	Autumn		Spring	
		Low	High	Low	High
2003	1.5	2.7	<u>5.7</u>	3.9	<u>7.5</u>
2004	2.8	3.1	<u>4.1</u>	6.1	<u>10.9</u>
2005	2.4	3.1	<u>4.9</u>	4.5	<u>9.6</u>

* Average of cultivars: *Rolan: Red Lake, Titania, Tenah, Weiße Langtr.*

Leaf sampling time: 03. Sept. 2003; 14. Sept. 2004; 18. Aug. 2005

**Chloride toxicity concn. for leaves:
15-20 mg Cl/g dry wt.**

The chloride toxicity concn. for leaves of red and black currants were not reached under field conditions at autumn application, but even not at spring application at the unusual high application rates!



Is there an effect of NaCl, particularly at spring application, on mobilization of cadmium?

Effect of high Chloride application rate in autumn or spring on the average chloride and cadmium concentration in the fruit press sap of 5 varieties* “long-term field experiment”

Chloride (mmol Cl/L press sap)			Cadmium (ug/L press sap)		
Control	Autumn	Spring	Control	Autumn	Spring
1.5	<u>2.1</u>	<u>4.1</u>	0.4	<u>0.3</u>	<u>1.6</u>

* Average of cultivars: *Rolan: Red Lake, Titania, Tenah, Weiße Langtr*

There was a clear increase in Cd concn. in the fruit press sap at the spring application date; this could not be observed at the autumn application date, even at the unusual high application rate!



■ Conclusions / Prospects

- There was adequate chloride leaching during winter period at the three field sites with different winter rainfall as well as in the soil column experiment to
 - avoid Cl toxicity symptoms in leaves,
 - avoid elevated Cl concn. in leaves and fruit press sap,
- thus, there is no need for use of chloride-free fertilizers!



- Interestingly, at high NaCl application rates, in particular at spring application, there was an enhanced Cd mobility detectable.
- This enhanced Cd mobility was due to Cd desorption by Na from NaCl and not by chloride as expected!
- There was, however, no remarkable increase of Cd concn. in leaves or fruit press sap, if NaCl has been supplied in autumn to red currants.

*Thanks for your attention !
Dankeschön!*



