

4-8-93

MEMORANDUM

SUBJECT: Boric acid RED Data Base Evaluation
DP Barcode #184953; EFGWB 93-0153

TO: PM 73/ Linda Propst/Mario Fiol
SRRD

PREPARED BY: P.J. Hannan, Chemist, Chemical Review Section 3, EFGWB

FROM: Brinson Conerly-Perks, Chemist, Chemical Review
Section 3, EFGWB *E.B. Conerly-Perks 4/8/93*

THROUGH: Akiva Abramovitch, Head, Chemical Review
Section 3, EFGWB
and *Akiva Abramovitch*
Henry Jacoby, Chief, Environmental Fate and Ground
Water Branch *Henry Jacoby*

BACKGROUND

Boric acid is noted for its use in the control of roaches but there also are more than 100 products containing this compound which are marketed as acaricides, algicides, fungicides, and herbicides. Indoor use sites for boric acid include lumber, ships, trains, trucks, households, and zoos. Applications to manholes ultimately could have an impact on sewage systems. Outdoor uses include treatment of agricultural crops, orchards, ornamentals, and lawns; food- and non-food requirements may be found among these uses. A mode of action of boric acid concerns its blockage of enzyme activity in the metabolism of phosphates. Boric acid exists in three crystalline forms, with melting points varying from 170 to 200 C.; its solubility in water is 13,000 parts per million. Dilute aqueous solutions contain predominantly undissociated H_3BO_3 molecules, the pK_a being 9.14 (1). The apparent acid strength of boric acid is increased by strong electrolytes that modify the structure and activity of the solvent water; in the presence of excess $CaCl_2$, the strength of boric acid becomes equivalent to that of carboxylic acids. It has been used as a preservative in natural products such as wood, rubber latex emulsions, leather, and starch products. It is also used in washing fruits to inhibit mold, and in mildew-resistant latex paints.

RECOMMENDATION

Because of the relatively small amount of boric acid used as a pesticide, and the already significant amounts of boron present in soil and water, EFGWB will not require any environmental fate data at this time.

A. Summary of environmental fate data reviewed:

The adsorption and desorption coefficients were determined to be <1 in a study (1) which was considered to be invalid because the soil texture was altered by the sieving procedures used.

B. Environmental Fate Profile:

Boric acid, borax, and boron-containing salts are ubiquitous in the natural environment. Because available boron occurs in nature in the form of a number of closely related compounds which differ chiefly in the water of hydration associated with the molecule and are not easily differentiated, the following discussion refers to the group as "boron" or "boron salts". The specie which occurs in solution is the BO_3^{3-} cation. More complex mineral forms containing boron may gradually release it in the form of borate as a result of weathering. The range of boron as a micronutrient in soil is 5-150 ppm, and representative surface soil contains 50 ppm. Boron salts occur naturally in low concentrations in most unpolluted waterways. The average concentration for boron in surface waters has been reported to range from 0.001 mg/liter (2) to 0.1 mg/liter (3). Seawater boron concentrations average 4.5 mg/liter (4). In some geographical areas such as the American Southwest, boron occurs in concentrations in surface waters that have been shown to be toxic to plants of commercial importance (5). Most of the naturally occurring boron is inorganic, but because it is an essential element for many organisms there is an organically-bound component. It is against this background of naturally occurring boron that judgments on the environmental fate of boron compounds must be made. Only 0.68% of the boric acid produced annually is used as a pesticide.

C. Data Requirements Table:

161-1	- hydrolysis	- - -	NR*
161-2	- photolysis in water	- - -	NR
161-3	- photolysis in soil	- - -	NR
161-4	- photolysis in air	- - -	NR
162-1	- metabolism, aerobic soil	- - -	NR
162-2	- metabolism, anaerobic soil	- - -	NR
162-3	- metabolism, aerobic aquatic	- - -	NR
162-4	- metabolism, anaerobic aquatic	- - -	NR
163-1	- leaching/adsorption/desorption	- - -	NR
163-2	- volatility, laboratory	- - -	NR
163-3	- volatility, field	- - -	Nr
164-1	- field dissipation, terrestrial	- - -	NR
164-2	- field dissipation, aquatic	- - -	NR

1

For further details, see, for example, Soil Chemistry by Bohn, McNeal and O'Connor, page 291 (1979), and The Nature and Properties of Soils by Nyle C. Brady, pages 489, 496-497 et passim. (8th eighth edition, 1974)

164-3 - field dissipation, forest - - - NR
 164-5 - field dissipation, long term - - - NR
 165-1 - rotational crop accumulation, confined - - - NR
 165-2 - rotational crop accumulation, field - - - NR
 165-3 - rotational crop accumulation, irrigated - - - NR
 165-4 - fish bioaccumulation, laboratory - - - NR
 165-5 - non-target species accumulation, field - - - NR
 201-1 - droplet size spectrum - - - NR
 202-1 - drift field evaluation - - - Nr

* NR = not required

D. DERs for all studies that support the RED:
 Attached 163-1: Ryan, Miyamoto, and Stochlein (below)

References:

- (1). J. Ryan, S. Miyamoto, J. T. Stochlein, 1977. "Relation of solute and sorbed boron to the boron hazard in irrigation water", Plant and Soil, 47 (1), 253-256.
- (2) D.A. Livingston, 1963. U.S. Geological Survey Professional Paper 440-G.
- (3) J.F. Kopp and R.C. Kroner, 1970. "Trace elements in water of the United States. U.S. Department of the Interior, Federal Water Pollution Control Administration, Cincinnati, Ohio,
- (4) K.J. Maier and A.W. Knight, 1991. "The toxicity of waterborne boron to Daphnia magna and Chironomus decorus and the effect of water hardness and sulfate on boron toxicity", Arch. Environ. Contam. Toxicol., 20, 282-287.
- (5) M.A. Lewis and L.C. Valentine, 1981. "Acute and chronic toxicities of boric acid to Daphnia magna Straus", Bull. Env. Contam. Toxicol., 27, 309-315.

Chemical Name: Boric acid

Chemical Code : Shaughnessy #011001

Reviewer: P.J. Hannan

Pesticide Type : Insecticide

Date: April 5, 1993

Uses: Control of roaches; flame retardant in cotton textile products; ointment and eye wash; intermediate chemical reagent.

	<u>Submitted Studies/ Addendums</u>	<u>DER/Addendum Review/Summary Identification</u>	<u>DER/Addendum Review/Summary Review Conclusions</u>	<u>Additional Data/Info Required?</u>
DEGRADATION-LAB:				
161-1. Hydrolysis	pK _a = 9.1			Note (1)
<u>Photodegradation:</u>				
161-2. In Water	NA			"
161-3. On Soil	NA			"
161-4. In Air	NA			"
<u>METABOLISM-LAB:</u>				
162-1. Aerobic Soil	NA			"
162-2. Anaerobic Soil	NA			"
162-3. Anaerob. Aquat.	NA			"
<u>MOBILITY:</u>				
163-1. Leaching and Adsorp./Desorp.	NA			"
163-2. Volatil.(Lab)	NA			"
163-3. Volatil.(Field)	NA			"
<u>DISSIPATION-FIELD:</u>				
164-1. Terrestr.(Soil)	NA			"
164-2. Aquat.(Sediment)	NA			"
164-3. Forestry	NA			"
164-4. Combin./Tank Mix	NA			"
164-5. Long Term Terr.	NA			"
164-5. Long Term Aqua.	NA			"
<u>ACCUMULATION STUDIES:</u>				
165-1. Conf. Rot. Crops	NA			"
165-2. Field Rot. Crops	NA			"
165-3. Irrigated Crops	NA			"
165-4. Fish (Lab)	NA			"
165-5. Aqua. Non-target Organ.(Field)	NA			"

SPRAY DRIFT:

201-1. Droplet Spect. NA

Note (1)

202-1. Field Spray Drift
Evaluation NA

"

GROUNDWATER MONITORING:

166-1. Small Prospect. NA

"

166-2. Small Retrospect. NA

"

166-3. Large Retrospect. NA

"

SURFACE WATER MONITORING:

167-1. Field Runoff NA

"

167-2. Surface Water
Monitoring NA

"

Note (1). No outdoor uses are reported for this compound, therefore hydrolysis and other data requirements are not operative.

TDMS0030

DATA EVALUATION RECORD

PAGE 1 OF

CASE GS0024

BORIC ACID & SALTS

STUDY 5

PM 300 09/04/80

CHEM 011001

Boric acid

BRANCH EFB

DISC 30 TOPIC 050515

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID 05020880

CONTENT CAT 01

Wild, A.; Mazaheri, A. (1979) Prediction of the leaching rate of
boric acid under field conditions. Geoderma 22(2):127-136.

SUBST. CLASS = S.

DIRECT RVW TIME = 37½ (MH) START-DATE

END DATE

REVIEWED BY: D. Harper

TITLE: Staff Scientist

ORG: Enviro Control, Inc., Rockville, MD

LOC/TEL: 468-2500

SIGNATURE: *Daniel Harper*

DATE: Dec. 4, 1980

APPROVED BY:

TITLE:

ORG:

LOC/TEL:

SIGNATURE:

DATE:

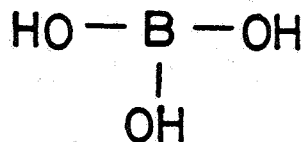
CONCLUSIONS:

Mobility - Leaching; Adsorption/Desorption

This portion of the study is scientifically invalid because the soil texture was so severely altered the resultant data are not representative of boric acid mobility in the environment.

Field Dissipation - Terrestrial

This portion of the study is scientifically invalid because no controls were run and boric acid application rates were not reported.

MATERIALS AND METHODS:

Boric acid

Samples of sandy loam (10% clay, 1.1% organic carbon, and pH 6.5) and "loamy clay" (46% clay, 8.5% organic carbon, and pH 7.5) soils were air dried and sieved. Soil particles in sizes ranging from 0.1 to 2 mm and 1 to 2 mm were retained, respectively. Subsamples of the retained soil subsequently were crushed to pass through a 1 mm sieve for the adsorption/desorption portion of the study.

Adsorption/Desorption

Soil samples (10 g) were shaken with 0.01 M CaSO_4 containing boron at 0-65 $\mu\text{g}/\text{cm}^3$ (as boric acid) for 22 hours at 22 C. The soil solution was centrifuged and the CaSO_4 solution was removed. The boron concentration of the solution was determined by the azomethine-H method of Mazaheri (1976). A sensitivity to boron of $\sim 0.1 \mu\text{g}/\text{m}$ with good reproducibility over concentrations ranging from 0.2 to 10 $\mu\text{g}/\text{m}$ was reported for this method.

A CaSO_4 solution without boric acid was added to the soil and the concentration of boron in the CaSO_4 solution was similarly determined.

The desorption isotherm was determined by replacing aliquots of solution with equal volumes of 0.01 M CaSO_4 . After reequilibration the procedure was repeated until the boric acid concentration dropped below the sensitivity of the method.

Leaching

Samples of sandy loam and "loamy clay" soil were packed into cylinders (7.5 cm diameter x 15 cm length) and eluted with 0.01 M CaSO_4 . The soil was eluted with a solution of KCl and H_3BO_3 (10 μg boron/ cm^3) in 0.01 M CaSO_4 and subsequently with 0.01 M CaSO_4 . The flow rate was regulated so that the soil remained submerged under 1 cm of solution. Successive 25-ml samples of the eluate were collected and analyzed by the azomethine-H method.

Field Dissipation

Sandy loam and "loamy clay" field plots were lightly forked and leveled. When field moisture capacity was obtained (due to rainfall), a 5-liter solution of H_3BO_3 (8 g boron) was added to the soil. Soil samples were collected after 85 and 136 mm of rainfall (49 and 84 days after treatment, respectively).

The soil samples were extracted with 0.01 M $CaSO_4$:mannitol solution (1:20) for 20 hours (Rhoades et al. 1970. Soil Sci. Soc. Am. Proc. 34:938-941). The extracts were analyzed for H_3BO_3 .

REPORTED RESULTS:

Adsorption/Desorption

By using the batch method, the coefficients of adsorption (b_{ads}) and desorption (b_{des}) were obtained from the plots of adsorbed H_3BO_3 against solution concentration (Figure 1).

Leaching

The elution curves for boric acid are presented in Figure 2. The adsorption coefficients are presented in Table 1.

Field Dissipation

After the plots received 3.4 inches of rainfall, boron residues were present to depths of 50 cm in the sandy loam soil and 40 cm in the "loamy clay" soil. After 5.4 inches of rainfall, boron residues were found at a depth of 50 cm in the "loamy clay" plot (Figure 3).

DISCUSSION:

1. The soil texture was severely altered by the sieving procedures employed. The sandy loam and "loamy clay" soil samples contained only fine to very coarse sand and very coarse sand particles, respectively. The soil particles were altered further by crushing to pass through a 1 mm sieve for the adsorption/desorption study. As a result of the sieving and crushing procedures used, the data generated are not representative of boric acid mobility in the environment.
2. The soil containing 46% clay was classified as a "loamy clay" soil. The term "loamy clay" is not consistent with the USDA soil classification system, and since a complete soil particle size analysis was not provided, the actual soil type cannot be determined. However, based on the clay content of the soil, the soil was either a sandy clay, clay, or silty clay soil.

3. The Freundlich coefficients in Table 2 were obtained from the data in Figure 1. The adsorption and desorption coefficients were all less than one, indicating that boric acid was mobile under the reported experimental conditions.
4. The amount of water used to elute the soil columns in the experimental time period was not specifically reported.

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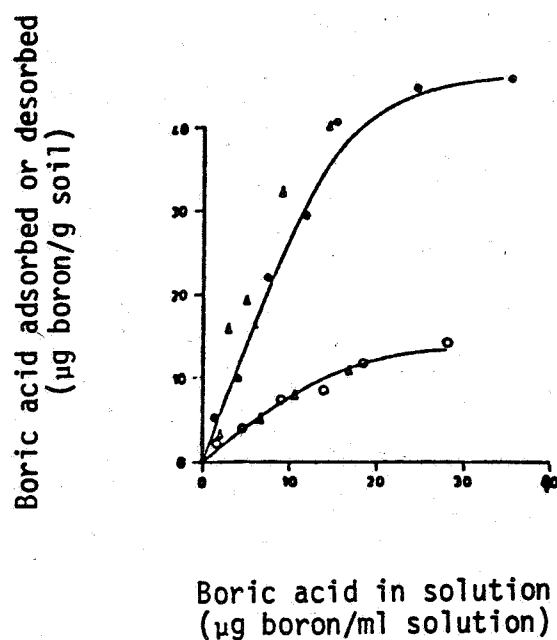


Figure 1. Adsorption/desorption isotherms of boric acid for two soils. Adsorption: \circ , sandy loam; \bullet , "loamy clay". Desorption: Δ , sandy loam; \blacktriangle , "loamy clay".

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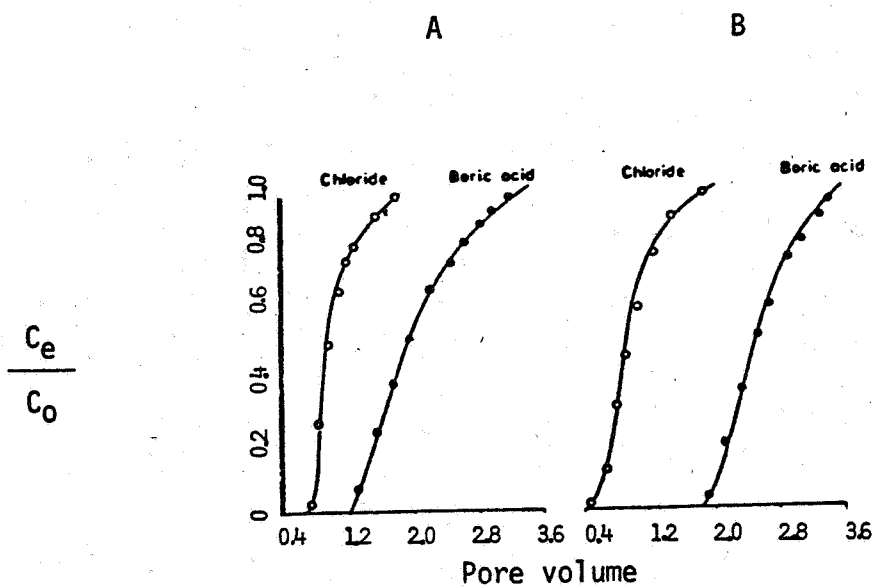


Figure 2. Elution curves of chloride and boric acid through soil. A: sandy loam; B: "loamy clay". C_e , exit concentration; C_0 , initial concentration.

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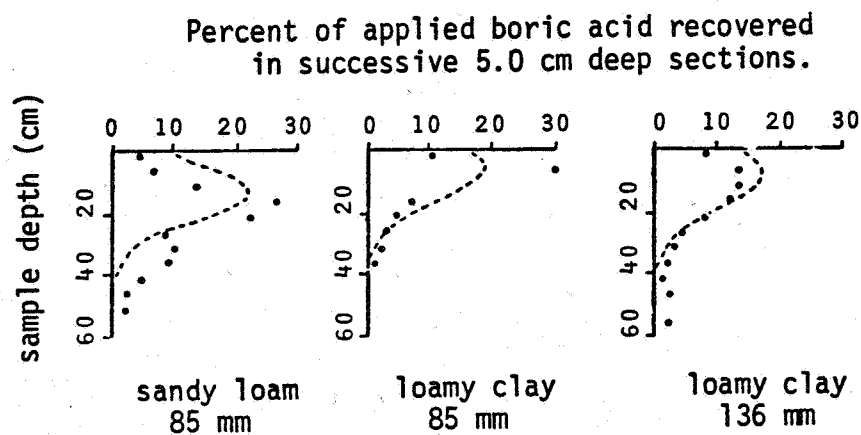


Figure 3. Vertical distribution of boric acid in field plots after winter rainfall of 85 and 136 mm. Broken line is the predicted vertical distribution.

Table 1. Soil parameters and adsorption coefficient at an exit concentration equal to one-half initial concentration.

Soil	Dry bulk density (g/cm ³)	Moisture content (cm ³ /cm ³)	Pore Volume observed	Adsorption ^a coefficient (cm ³ /g)
Sandy loam	1.44	0.35	1.90	0.23
"Loamy clay"	0.73	0.63	2.45	1.34

^a Calculated using the equation: $\text{pore volume} = (1 + \frac{b\rho}{\theta})$ where

b = adsorption coefficient

ρ = dry bulk density

θ = volumetric moisture content

Table 2. Adsorption of boric acid to soil.^a

Soil	Parameter	K	$\frac{1}{n}$	r ²
Sandy loam	Adsorption	0.02	1.26	0.957
	Desorption	0.45	1.70	0.982
"Loamy clay"	Adsorption	0.56	1.15	0.960
	Desorption	0.94	1.22	0.955

^a Calculated by the reviewer from the data in Figure 1 using the equation $\log \frac{x}{m} = \frac{1}{n} \log C + \log K$