Value of Micronutrients to the Farmer

Martin R Phillips
Borax Europe Ltd

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Zinc in Maize - Increased Yield and Value of Maize applied with Zn - China

Treatment	Rate of ZnSO4 (kg/hm^2)	Yield (kg/ha^{-1})	Yield increase (kg/ha^{-1})	Value of application (US$)
Starter fertilization in soil	22.5	9668	1082	141.48
Mixed with seeds	0.36	9502	916	128.24
Foliar 3 times from jointing stage	2.25	9463	877	121.88
Untreated	0	8586		

(Sun et al., 2005) Field trial, Liaonin province

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Zinc Deficiency in Maize – China

Photo . B Alloway

Wide chlorotic areas near base of leaves –rosetting of leaves

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Zinc in Cereals and Cotton on Different Soil Types - India

Crop	Soil	Location	Available Zn (mg kg-1)	Rate of Zn (kg ha-1)	Yield increase (kg/ha-1)
Wheat	Entisols	Ludhiana	0.3	10	1270
Wheat	Calcareous Entisols	Pusa	0.45	5.25	1275
Wheat	Vertisols	Mandsaur	0.7	5.25	1430
Wheat	Entisols	Hisar	0.42	5	1110
Wheat	Vertisols	Junagadh	0.38	5.25	3050
Wheat	Vertisols	Bahraich	-	2.1	420
				5.47	970
Rice	Inceptisols	Varanasi	0.43	8.4	1110
Rice	Alfisols	Karnal	-	8.4	110
Rice	Calcareous Entisols	Pusa	0.47	5	780
Rice	Vertisols	Hyderabad	0.57	5	573
				6.7	889
Maize	Calcareous Entisols	Pusa	0.55	5	350
Maize	Ultisols	Pudukkotal	0.5	6.3	1521
				5.65	936
Cotton	Inceptisols	Ludhiana	0.5	5.6	430
Cotton	Inceitpsols	New Delhi	-	5.25	215
				5.42	323

Rattan, R.K., Datta, S.P., Saharan Neelam and Katyal, J.C. Fertil. News, 42(12): 75-89 (1997).

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Zn in Cereals and Cotton, India. Yield Improvement and Value to farmer

Improvement Level	Rate Zn /ha	Cost Zn (US$/ha^{-1})	Yield Increase (kg/ha^{-1})	Value of Increase (US$/ha^{-1})	Cost Benefit Ratio
Wheat					
Lowest	2.1	5.0	420	104.2	21:1
Average	5.47	**13.1**	**970**	**139.0**	**11:1**
Best	5.25	12.6	3050	780.4	62:1
Rice					
Lowest	5	12.0	573	137.0	11:1
Average	6.7	**16.1**	**889**	**118.0**	**7:1**
Best	8.4	20.2	1110	268.4	13:1
Maize					
Lowest	5	12.0	350	79.0	7:1
Average	5.65	**13.6**	**936**	**112.0**	**8:1**
Best	6.3	15.1	1521	380.3	25:1
Cotton					
Lowest	5.25	12.6	215	43.3	3:1
Average	5.42	**13.0**	**323**	**132.0**	**10:1**
Best	5.6	13.4	430	98.4	7:1

Compiled from: Rattan, R.K., Datta, S.P., Saharan Neelam and Katyal, J.C. Fertil. News, 42(12): 75-89 (1997).

Assumes : Wheat $144 mt , Rice $133, Maize $120 , Cotton $411.

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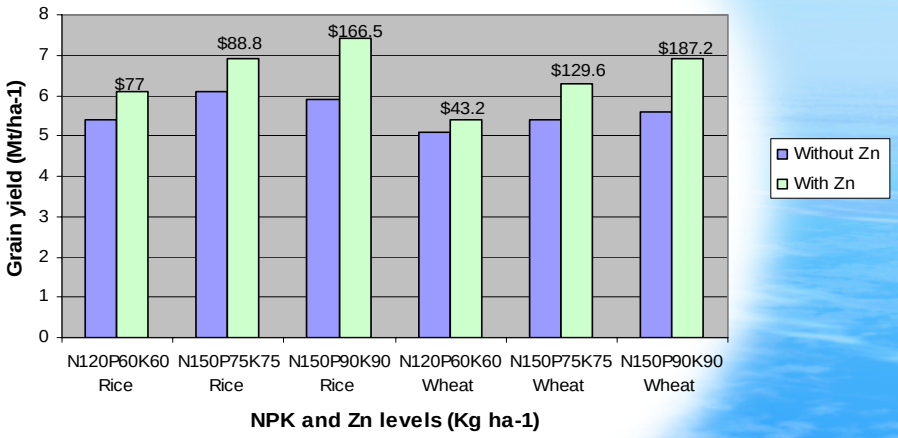
Productivity and Extra Value of Rice-Wheat System with NPK Fertiliser and NPK + Zn – India



Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore (1994).

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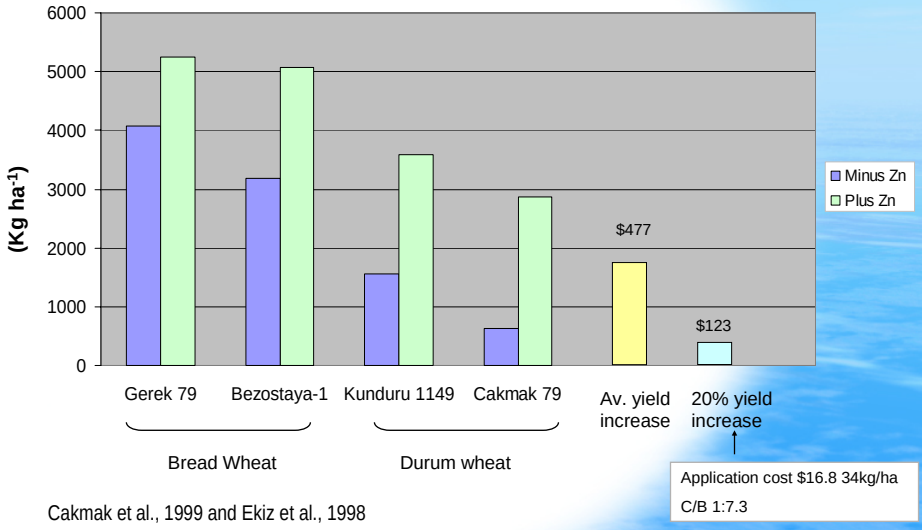
Yield Increase in Irrigated Wheat after Zn Application - Turkey



Cakmak et al., 1999 and Ekiz et al., 1998

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Interveinal Chlorosis and Necrotic Areas on Tips and Blades of the Leaves

Source: Dr V M Shorrocks, Micronutrient Bureau

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Boron in Basmati Rice - Pakistan, Influence on Yield Parameters

Cultivar	B applied (kg ha^{-1})	Yield (mt ha^{-1}) Paddy	Increased Yield (mt ha^{-1})	Panicle sterility (%)	Plant height (cm)	1000-grain weight (g)
Basmati-385	0	3.77		28	134	19.4
	1	4.72	0.95	16	140	20.1
Super Basmati	0	3.23		23	116	19
	1	3.89	0.66	14	122	20.2

A. Rashid, M. Yasin. National Agricultural Research Council - Pakistan

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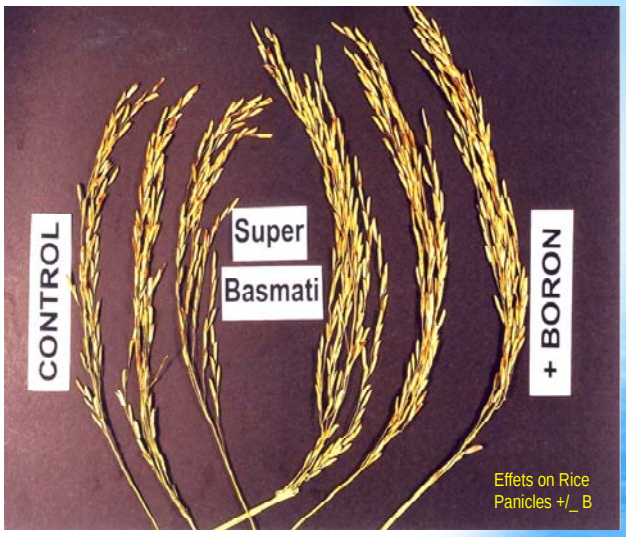
Boron in Rice – Pakistan



Dr A Rashid NARC Pakistan

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Increases in Yield on a Range of Crops using Boronated Fertiliser – India

Crop	Total Trial No	Median Increase in Yield (%)
Pomegranate	4	29.0
Cabbage	10	25.0
Tobacco	5	25.0
Cauliflower	7	22.9
Maize	14	20.3
Banana	7	20.0
Mustard	29	14.3
Sugarcane	33	12.6
Peas	6	12.5
Wheat	46	11.0
Paddy	14	10.0
Tea	4	8.0
Cotton	48	7.1
Potato	92	6.3
Brinjal	5	5.3

India Farmers Fertiliser Cooperative (IFFCO)

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Increases in Yield and Benefits to the Farmer of Boron Enriched Fertiliser 10 : 26 : 26 : 0.3 % B – Gujarat and W Bengal - India

Crop	Av. Yield (qt/ha)	Av. Increase in Yield %	Av. Selling Price (Rs qt)	Value of Increased produce Rs/ha ($/ha)	Doses Applied kg/ha	Cost of B Added (@ Rs 35 per bag) (total cost $)	Benefit Cost Ratio
Wheat	20	12.5	650	1625 (**$ 63**)	150 (3bags)	105 ($2.3)	27.0:1
Rice (Kharif)	40.6	9.8	500	1989 (**$44**)	200 (4 bags)	140 ($3)	14.6:1
Mustard	11.25	14	1300	2048 (**$46**)	260 (5.2bags)	182 ($4)	11.5:1
Maize	15.9	21.12	750	2519 (**$56**)	100 (2 bags)	70 ($1.6)	35:1
Cotton	36.8	7.14	1400	3679 (**$82**)	300 (6 bags)	210 ($4.6)	17.8:1
Potato	200	7.1	300	4260 (**$95**)	600 (12 bags)	420 ($9.3)	10.2:1
Tobacco	10	25	2500	6250 (**$139**)	125 (2.5 bags)	87.5 ($2.7)	51.4:1
Cauliflower	250	22.5	300	16875 (**$375**)	375 (7.5 bags)	262.5 ($5.8)	64.6:1
Cabbage	300	25	300	22500 (**$500**)	470 (9.4bags)	329 ($7.3)	68.4:1

Source - Indian Farmers Fertiliser Cooperative New Delhi

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Farmers Responses and Acceptance of Boronated Fertiliser – India

Comment	No of positive responses by farmers (366 trials in Total)
Saw a difference between boronated and non boronated	357
Noticed better growth	357
Increased plant height	259
Differences in yield of seeds and fruit	242
Difference in quality of seeds / fruit	156
Earlier maturity	195
Will you buy next season	348
Are you willing to pay extra	224

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Benefits seen by Farmers - IFFCO, India

Cotton:
- Better flowering and retention of flowers
- Healthy squares and bigger bolls
- More vigorous and greener plants with thicker stems with bigger canopy
- Very high seed yield

For seed producers the seed yield observed was very high as they have observed more than 20 % increase in seed yield

Maize:
- No barren top and cob were filled to the top
- Plant remained green till harvest and given very good fodder
- Disease resistance observed

Mustard:
- Bigger plant canopy with thicker branches
- Bigger pods (Siliqua) and bigger grains

Indian Farmers Fertiliser Cooperative (IFFCO)

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IFFCO, India, - Benefits seen by Farmers

Peas:
- Healthier plant and more filling in pods
- Bigger grains
- Better physical appearance in green peas

Potato:
- More vigorous plant and thicker stem
- No/ less cracking of tubers
- Shine on tubers

Rice:
- Less chaffy grains and better grain filling

Cabbage and Cauliflower:
- Yield increased by 400-600gm per fruit.
- Better physical appearance, brighter curds

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Boron application on Cauliflower in China

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Boron in Crops, West Bengal, India

Boron In Crops India . Additional profit (Rs. [$]) per ha with boronated NPK (10:26:26:0.3) versus NPK (10:26:26) on yield of different Rabi crops and succeeding crops (2003-04)

Site of the experiment	Main crops	Additional profit in Rs.($) per ha with BNPK	Succeeding crops	Additional profit in Rs.($) per ha with BNPK	Total additional profit in Rs.($) per ha with BNPK
Alluvial soils of West Bengal	Mustard	5907**(131)**	Rice	288**(6)**	6195**(138)**
	Mustard	11907**(265)**	Rice	1150**(26)**	13057 **(290)**
	Wheat	2225**(49)**	Jute	1500**(33)**	3725**(83)**
	Lentil	545**(12)**	Jute	-	545**(12)**
	Coriander	1394**(34)**	Jute	1000**(22)**	1494 **(56)**
Terai soils of West Bengal	Mustard	9907**(220)**	Jute	500**(11)**	10407**(231)**
	Mustard	1907**(42)**	Rice	288**(6)**	2195**(49)**
	Wheat	1250**(28)**	Jute	-	1250**(28)**
	Wheat	2485**(55)**	Rice	288**(6)**	2773**(62)**
	Wheat	1510**(34)**	Rice	863**(19)**	2373**(53)**
	Potato	2655**(59)**	Rice	863**(19)**	3518**(78)**

B Mandal, A.K. Sarkar, D. Jena, D Sarkar - Bidhan Chandra Krishi Viswavidyalaya. Kalyani – West Bengal

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Boron In Mustard Seed, West Bengal - India

B Mandal, A.K. Sarkar, D. Jena, D Sarkar - Bidhan Chandra Krishi Viswavidyalaya. Kalyani – West Bengal

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Influence of Boron Spray Application on Uptake of N, P, and K in Cotton - India

Treatments	Total uptake by cotton (kg ha^{-1})			
	N	P	K	B (g/ha)
Control (Recommended NPK)	29.17	6.99	15.91	10.74
Solubor spray @ 1.125 g/lit (x3)	36.84	8.89	20.25	13.47
Solubor spray @ 1.50 g/lit (x3)	51.96	13.41	31.28	19.75
Solubor spray @ 1.875 g/lit (x3)	38.51	9.43	21.26	15.45

Marathwada Agricultural University - India 2003, Parbhani

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Importance of Boron in Reducing Disease and Susceptibility to Pests

- Eucalyptus - Botryosphaeria ribis y Lasiodiplodia theobromae – Piracicaba Brazil
- Sugar Beet - Powdery mildew and Cercospera beticola – Hungary
- Almond - Reduction of Gumosis in Fruits, resistance to attack from Stigmina carpophila – Kotkhai (India)
- Mijo- Mildew Sclerospora graminicola reduction - Jodhpur, India
- Caulifower - Black rot (Xanthomonas campestris) – Bihar, (India)
- Brassica crops - Club root Plasmodiophora brassicae
- Forests - Resistance to Tyromyces palustri y Coriolus versicolor - Kiyoto Japan

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Boron Deficiency in Cauliflower - India

Dr E. Raja Indian Institute of Horticultural Research

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Before and After : The Boron Effect

Photo C/oRallis India Ltd

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Capsule and Flower Drop in Cotton – India

Photo C/oRallis India Ltd

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Observing Effect of Solubor on Seed Filling in Sunflower – India

Photo C/oRallis India Ltd

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Solubor application effects on Oil rapeseeds in Hubei, China

Photo from Mr. Peter zhao, Rio Tinto Borax China

Granubor application effects on Oil rapeseeds in Henan, China

Photo from MS. Wu haiying,Nanyang Banglong Plant Protection Co.,Ltd

Observing Effect of Solubor on Cotton – Xinjiang,China

Photo from Mr. Wangchang, Xinjiang production and construction corp

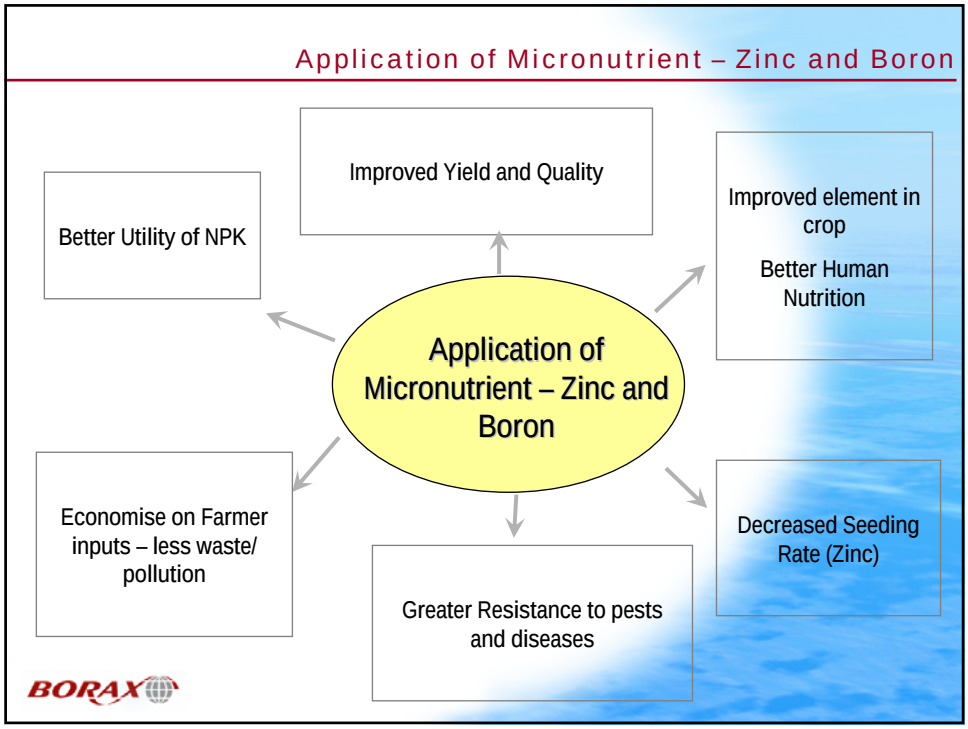
Human Health Effects of Zinc and Boron Deficiency

Zinc

- Impaired wound healing
- Impaired growth in infants and children
- Impaired immune system
  - Infections
  - Diarrhoea
  - Pneumonia
  - Maternal health
  - Pregnancy outcomes

Boron

- Needed during rapid cell replication subsequent to fertilization
- Ameliorates some adverse effects on bone of vitamin D deficiency
- Dietary B intakes shown to alter human steroid hormone levels
- Diets depleted in B shown to affect both the immune and nervous systems


Application of Micronutrient – Zinc and Boron
Improved Yield and Quality
Better Utility of NPK
Improved element in crop
Better Human Nutrition
Application of Micronutrient – Zinc and Boron
Economise on Farmer inputs – less waste/ pollution
Decreased Seeding Rate (Zinc)
Greater Resistance to pests and diseases
BORAX