The general equation that describe the effect of boron on dry weight is:

$$y = 0.855666 + 0.815849B - 0.016688B^2$$

$$R^2 = 0.6789^{++}$$

All cultivars presented boron toxicity. The plant requeriment for maximum growth was 24.590 ppm. When individual response were taken the boron requirement for maximum growth fell into the interval 24.403 to 24.859 ppm in the nutrient solution for 6 out of 9 cultivars under study. Lower levels (0.5 ppm) proved to be detrimental for Mulatinho Paulista, Jamapa and Goiano Precoce.

*****

EFFECTS OF BORON, MOLYBDENUM AND ZINC ON BEAN YIELD

Itamar P. Oliveira
National Research Center For Rice and Beans-CNPAF
C.P. 179, 74.000, Goiania, Goias - Brazil

The cerrado (savannah) soils of Brazil represent approximately 21% of the total land area of the country and are characterized by a slightly undulated topography. This special topografic condition permits cultivation of extensive areas employing mechanical agricultural practices.

The natural fertility of the soil is very poor with low availability of phophorus, potassium, calcium, and high aluminum and hydrogen content considered detrimental to plant growth.

Micronutrient deficiencies (boron, molybdenum, zinc, iron, manganese, and copper) have been observed in some crops cultivated in cerrado soils.

The uncertainty in the basic soil chemistry of micronutrients and the analytical difficulty of determining the small amount of these elements present in the soil solution have not helped researchers to develop reliable soil estimation. Plant analysis has been more common as it was often more rapid and reliable but it has had to be interpreted with caution considering many interactions involved.

Preliminary research has showed that micronutrients are very important to bean plant, influencing mineral composition and plant growth but their influences on grain production are still to be determined and need further study.

Two field experiments with Tayhu cultivar were carried out to observe boron, molybdenum and zink effects on bean (*Phaseolus vulgaris* L.) yield and yield components. Two levels of zinc (0 and 30 kg/ha $ZnSO_4$), two levels of molybdenum (0 and 14,5g Mo_2O_3/50 kg of seed), and two levels of boron (0 and 7,5 kg H_3BO_3/ha) were used in all combinations. Treatments were replicated three times in a randomized block design. Basic fertilization was made using 60 kg P_2O_5/ha as simple superphosphate and 40 kg K_2O/ha as potassium chloride in presence and absence of nitrogen.

Yield was significantly affected by combined application of zinc, boron, and molybdenum (Zn x Mo x B) in the first year but there was no effect of single element application (Table 1). The majority of treatments was detrimental to the grain yield.

Yield components (pods/plant, grains/pod, weight of 100 grains and height of plant) were not affected by the application of micronutrients under study.

These results reflect the actual fertility conditions including management and climatic conditions. Application of fertilizer plus the environmental conditions may result in satisfactory production but there was no observed effects of micronutrients on bean yield in the second year.

According to the initial cerrado soil condition the combination of boron, molybdenum and zinc is very important to obtain excellent bean grain yield.

Table 1 - Analysis of variance and treatment effects on mean yield of bean ($\bar{x}$) and increases (+) or decreases (-) of mean yield ($\Delta\bar{x}$) using different micronutrient combinations.

Source of variation	D.off.	Sum of Squares	Yield mean ($\bar{x}$)	$\Delta\bar{x}$
Blocks	2	77.3192	-	-
Treatments	15	908.0451**	-	-
N	1	1151.5982	200	- 235.11
Zn	1	107.3111	507	+ 71.77
Mo	1	662.5331	257	- 178.33
B	1	75.3254	495	+ 60.13
N x Zn	1	48.8639	483	+ 48.43
B x Mo	1	31.7038	474	+ 39.01
N x B		895.1905*	228	- 207.29
Zn x Mo	1	448.0463	582	+ 149.65
Zn x B	1	109.2335	363	- 72.41
Mo x B	1	618.5570	263	- 172.31
N x Zn x Mo	1	1302.1875**	185	- 250.01
N x Zn x B	1	443.5360	289	- 145.91
N x Mo x B	1	1500.0206**	167	- 268.33
Zn x Mo x B	1	4079.4813**	888	+ 442.51
N x Zn x Mo x B	1	2147.0888**	114	- 321.03
Error	30	166.3092	-	-
Total	47	-	-	-