TECHNICAL NOTES

BORON STUDIES ON A KRASNOZEM SOIL IN QUEENSLAND

I. INTRODUCTION.

Boron deficiency symptoms have been recorded over the past few years in a number of vegetable crops in the Redlands district, near Brisbane, which is the main vegetable growing area in Queensland. The deficiency has been evident particularly under conditions of moderate to heavy liming. Most growers in the affected area now apply borax either in fertilizer mixtures or in foliage sprays.

A field trial was conducted at the Redlands Experiment Station, Ormiston, to obtain information on the boron status of the main Redlands soil type, the changes in available (water-soluble) boron that occur during the growing period, and the uptake of boron by an indicator plant—beetroot.

II. SOIL AND CLIMATE.

The soil of the trial area falls into the Great Soil Group Krasnozem (Stephens 1956). It shows considerable evidence of lateritisation. Iron concretions occur extensively below 12 in., though their distribution is somewhat haphazard. The profile description to 48 in. is as follows:—

A 0–10″ Brown loam; loose crumb/clod.

B_1 10″–17″ Red brown clay loam; loose clod, becoming more compact with depth.

B_2 17″–26″ Red brown clay loam.

B_3 26″–48″ Dark red clay with iron concretions; compact structure.

The soil had not been limed and was acid in reaction. A composite sample of 0–10 in. from all plots before treatment showed the following composition:—

pH	5·7
Total N (%)	·14
Available P_2O_5 (p.p.m.)	28
Replaceable K (m.-equiv. %)	·47
Total replaceable bases (m.-equiv. %)	16·6
Available boron (p.p.m.)	·10

The Station receives heavy monsoonal rain during the first three months of the year and considerable leaching of plant nutrients takes place during this period. Cropping of one type or another is practised throughout the year, and the trial reported here was conducted after the wet season had ended to minimise the effect of transfer of plant foods by high rainfall.

III. EXPERIMENTAL.

The trial was conducted on a block of one-tenth of an acre. There were 4 replications of the following five treatments:—

A. Control

B. 10 lb. borax per acre

C. 30 lb. borax per acre

D. 50 lb. borax per acre

E. 100 lb. borax per acre

The beetroot seed was planted on Apr. 21, 1956, and thinning was carried out on May 10. Borax treatments were given on May 20, the borax being dissolved in water and applied to the soil with a watering can to ensure as even a distribution as practicable.

To correct a possible molybdenum deficiency, all plants were sprayed on May 30 with a solution of $\frac{1}{2}$ oz. ammonium molybdate to $3\frac{1}{2}$ gal. water. At fortnightly intervals for two months after treatment, soil samples were taken from each plot for the determination of boron.

Before harvesting was commenced, the youngest two leaves from four plants in each plot were collected and oven-dried for boron analysis.

Analyses were conducted according to the method suggested by Dible, Truog and Berger (1954), which is as follows:—

Available Soil Boron.—Place 20 g. (air-dried) soil in a 250 ml. Erlenmeyer flask free from boron, add 40 ml. water and reflux for 5 minutes. Add 2 drops conc. $CaCl_2$ solution, stir and centrifuge until clear. Take 1 ml. aliquot and proceed with the colour development procedure.

Boron in Plant Tissues.—Place a 1 g. sample of plant material, oven-dried and ground, in a porcelain crucible and ash in a muffle furnace at 550 deg. C. Dissolve the ash in 5 ml. 0·1N HCl and dilute with water to 50 ml. Take 1 ml. aliquot and proceed with the colour development procedure.

Colour Development Procedure.—Place a 1 ml. aliquot of the water solution, containing 0·0–2·0 boron, in a 250 ml. beaker (boron-free). Add 4 ml. curcumin-oxalic acid solution (0·04 g. curcumin and 5 g. oxalic acid dissolved in 100 ml. ethyl alcohol), and mix thoroughly by rotating the beaker. Evaporate on a water-bath at 55 ± 3 deg. C., and continue to bake the residue at the same temperature for a minimum of 15 minutes to ensure complete dryness. Cool and add 25 ml. 95% ethyl alcohol. Centrifuge or filter the solution and read colorimetrically, using a 540μ filter. Determine the boron concentration by reference to a standard curve.

IV. RESULTS AND DISCUSSION.

(1) Changes in Soil Boron.

The results of the soil analyses are shown in Tables 1 and 2 and the decrease in soil boron during growth is depicted in Fig. 1.

Table 1.

BORON CONTENT (p.p.m.) OF SOIL IN EACH PLOT AT FORTNIGHTLY INTERVALS.

Date.	Control.				10 lb./acre.				30 lb./acre.			
June 3	·12	·32	·32	·32	1·20	·96	1·24	1·08	3·04	1·52	3·60	4·24
June 17 ..	·16	·16	·36	·28	·88	1·28	1·52	1·28	2·32	1·28	2·52	2·72
July 1	·24	·48	·24	·52	·60	1·08	1·52	1·12	2·12	1·60	2·40	2·16
July 15 ..	·32	·32	·24	·34	·16	·72	1·60	0·32	2·24	1·64	1·92	3·60
July 29 ..	·44	·12	·08	·24	1·08	1·08	·96	2·92	1·88	1·36	1·36	2·52

Date.	Control.				50 lb./acre.				100 lb./acre.			
June 3	·12	·32	·32	·32	5·28	3·28	6·56	3·76	6·64	8·00	7·36	6·88
June 17 ..	·16	·16	·36	·28	8·80	2·24	4·32	6·00	5·82	5·60	8·80	4·28
July 1	·24	·48	·24	·52	5·04	2·84	2·96	3·20	6·00	4·40	6·64	4·40
July 15 ..	·32	·32	·24	·34	2·40	3·56	3·12	2·32	2·64	3·32	3·56	2·92
July 29 ..	·44	·12	·08	·24	2·64	2·44	4·56	2·36	1·88	4·08	2·80	3·04

Table 2.

TABLE OF EQUIVALENT MEANS—BORAX CONTENT (p.p.m.) OF SOIL.

Treatment.	3–6–56.	17–6–56.	1–7–56.	15–7–56.	29–7–56.
100 lb./acre Borax ..	7·24	5·92	5·27	3·09	2·82
50 lb./acre Borax ..	4·57	4·79	3·39	2·82	2·88
30 lb./acre Borax ..	2·88	2·14	2·19	2·24	1·70
10 lb./acre Borax ..	1·10	1·20	1·02	·81	1·35
Control	·25	·22	·35	·30	·18

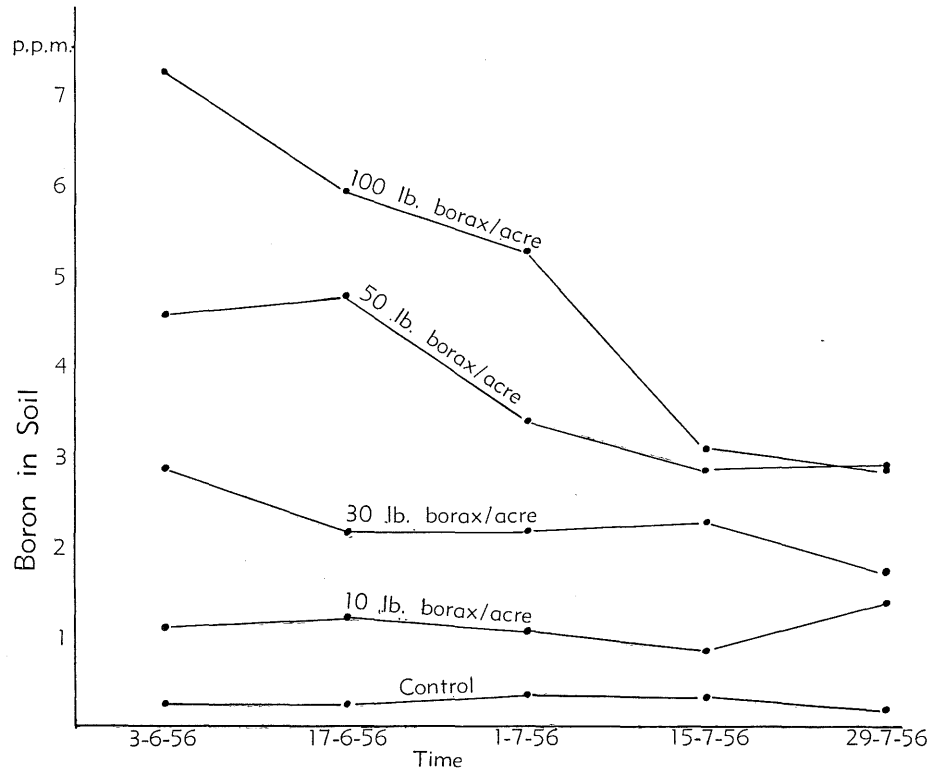

Fig. 1.

Boron Content of Plots at Fortnightly Intervals After Application of Borax.

There is little change in water-soluble soil boron either in the control plots or in those receiving 10 lb. borax per acre. At higher rates of application there is a sharp decrease in boron during the first six weeks, after which the decrease is very small. The rise in the curve for the 50 lb. per acre application may be due to sampling error consequent on uneven distribution of the borax at application.

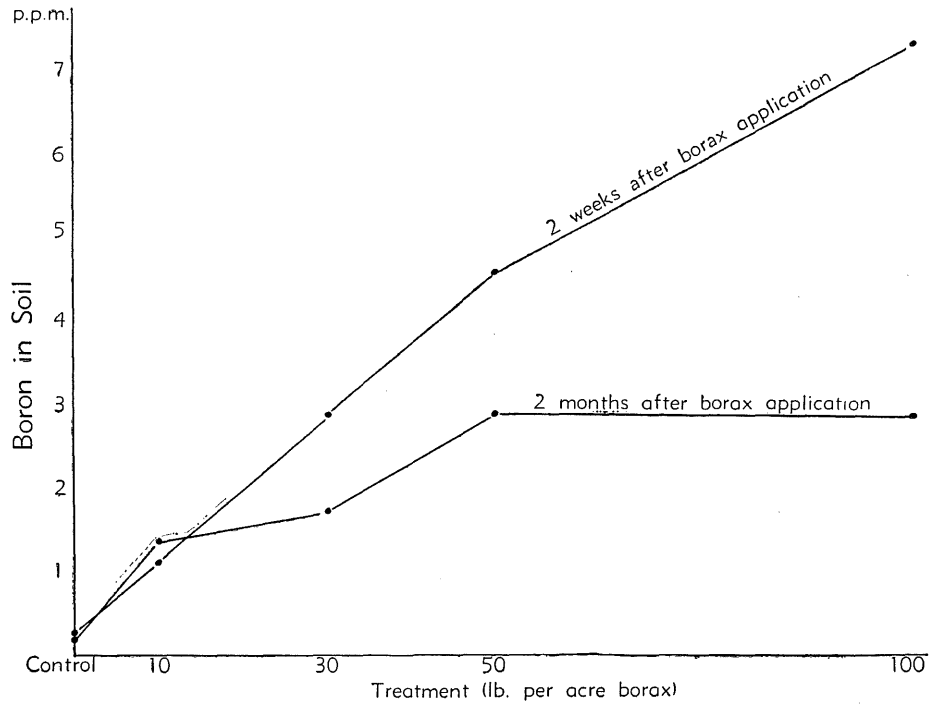

Fig. 2.

Soil Boron Content of Plots at Two Weeks and Two Months After Application of Borax.

Fig. 2 shows the increase in water-soluble soil boron with increasing rate of application of borax at two stages of the trial. Initially, this increase is almost linear, but two months after treatment the curve has a more gradual slope. Loss of boron has occurred in those plots receiving 30 lb., 50 lb. and 100 lb. This loss is attributable to leaching by rain and irrigation water, fixation by the soil, and increased uptake of boron by the plant, the last being the least important.

(2) Uptake of Boron.

The results of plant analyses are given in Table 3 and Fig. 3. Plant boron content rises with increase in rate of application of boron to the soil. The rise in plant boron content was not accompanied by any visible effect on growth or any toxicity symptoms, even when soil boron content was over 7 p.p.m.

Table 3.

PLANT ANALYSES.
(*p.p.m. Boron*).

—	Control.	10 lb./acre.	30 lb./acre.	50 lb./acre.	100 lb. acre.
Replication 1..	21	7	18	22	41
Replication 2..	10	21	21	40	71
Replication 3..	10	19	24	31	60
Replication 4..	16	16	33	24	42
Equivalent Means	13·5	14·4	23·4	28·2	52·7

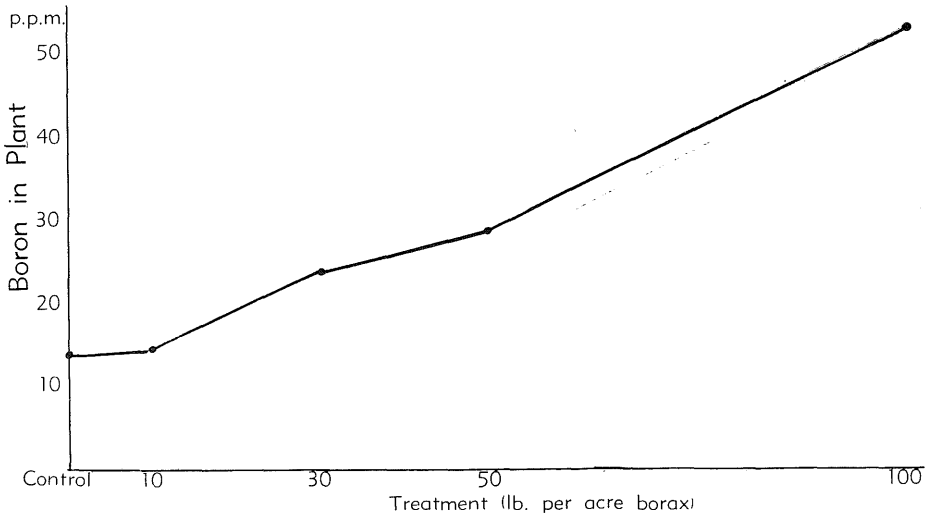

Fig. 3.

Plant Boron Content in Relation to Soil Applications of Borax.

No deficiency symptoms occurred in the control plots. Presumably at the pH of 5·7 the availability of boron in the soil was sufficient to enable normal growth to be made even at a soil boron level which is considered by some workers to be below the critical level.

There were no significant differences between treatments in yield of harvested roots.

REFERENCES.

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J. D. HUGHES,
Chemical Laboratory, Division of Plant Industry.