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NITROGEN AND BORON RATES FOR BROCCOLI, CAULIFLOWER, CHINESE CABBAGE, AND CHINESE MUSTARD GROWN ON A BOWIE FINE SANDY LOAM SOIL

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INTRODUCTION

Broccoli (*Brassica oleracea* L. Italica), cauliflower (*Brassica oleracea* L. Botrytis), Chinese cabbage (Pe-tsai) (*Brassica rapa* L. Pekinensis), and Chinese mustard (Pak-choi) (*Brassica rapa* L. Chinensis) are crops which are currently being investigated as specialty vegetable crop alternatives for East Texas. Soils of East Texas are usually acid and sandy with low levels of fertility and organic matter and low water holding capacity. These conditions are conducive to excessive leaching of plant nutrients, especially nitrogen (N) and boron (B). Current suggestions for N and B rates for production of these crops are lacking. Existing recommendations are for other areas of Texas which have different soil types and climate (Hartz and Longbrake, 1983), or for other areas of the United States and Canada (Cutliff and Munro, 1971; Dufault and Waters, 1985; Hipp, 1971; Lorenz and Maynard, 1988). Nitrogen and B rates for Chinese cabbage and Chinese mustard are not currently available. Lorenz and Maynard (1988) report that the B requirements of broccoli and cauliflower are high. These four vegetables are in the same genus and could be assumed to have similar B requirements. This, however, has not been substantiated on East Texas soils. This study was initiated to determine the rate and combination of N and B required for maximizing growth of the four *Brassica* species to ensure optimum plant growth and production of a quality salable product.

MATERIALS AND METHODS

Broccoli and cauliflower - Fall 1987.

Five rates of N were interacted with 3 rates of B in a 5 x 3 factorial experiment in a randomized complete block design (Gomez and Gomez, 1984) with 3 replications. Methyl bromide was applied to the experimental area at the rate of 200 lbs a.i./ac on 12 Aug. 1987 for weed control. The fertilizer treatments included all possible combinations of 0, 50, 100, 150, and 200 lbs N/ac from ammonium nitrate (NH_4NO_3) and 0, 1.2, and 2.4 lbs B/ac from BORATE 40®. On 22 Sept. 1987, pre-plant applications of 60 lbs phosphorus (P) as P_2O_5 and 44 lbs K_2O, 22 lbs Mg and 45 lbs S/ac from K-Mag® ($KMgSO_4$) were applied 4 in deep in a double band 12 in apart on a single bed. Individual plot areas consisted of four 40 in beds 20 ft

long. Plots were planted on 24 Sept. 1987. Broccoli transplants (Green Comet) were spaced 12 in apart in the row and cauliflower (Snow Crown) 24 in. The outside two rows of each plot were planted with broccoli. Data were taken from the middle 10 ft of the two inside rows in each plot. Postplant surface applications of one-half the N rates and all the B rates were made on 28 Sept. 1987. The remaining N was applied 19 Oct. 1987. The Bowie fine sandy loam (fine - loamy, siliceous, thermic Plinthic Paleudult) had an initial pH of 6.4. Trickle irrigation was used and pest control was by recommended procedures (Hartz and Longbrake, 1983).

Chinese cabbage, Chinese mustard and broccoli - Spring 1988.

The broccoli and cauliflower area used in the 1987 test was tilled and the beds reshaped on 8 Dec. 1987. The same experimental design, fertilizer rates and plot amplitude used in the spring test was duplicated in the fall test with the exception that N rates were applied in three equal split applications and B was not reapplied. The P and K-Mag were pre-plant applied on 7 Mar. 1988. On 9 Mar. 1988, transplants of Chinese cabbage (Monument) were spaced 18 in. and Chinese mustard (What-A-Joy) 12 in. apart in the outside rows 1 and 4. The inside rows were planted to the same varieties of broccoli and cauliflower as in the 1987 trial, with the same in-row spacing. Postplant applications of N were made on 15 Mar., 5 Apr., and 25 Apr. 1988.

RESULTS AND DISCUSSION

Broccoli heads were harvested 23 Nov. and 2 Dec. 1987 (60 and 69 days post transplant). Each increase of N application on the broccoli increased average head weight (HW), average head size (HS), and total yield (Y) (Table 1). Broccoli HW was significantly increased through the 100 lb N/ac rate. The HS was significantly increased only by the first 50 lb N/ac. Though nonsignificant, a trend indicated continued increases in HW and HS up to 200 lbs N/ac. Total yield of broccoli increased for each increment of added N. The first 50 lb N/ac rate gave an 89% increase in Y over plots which received no supplemental N. Since broccoli Y was still increasing at the 200 lb N/ac rate, highest absolute growth probably was not obtained under the growing conditions of this trial and higher N rates could be economically feasible.

When broccoli harvest data were evaluated in relation to added B, all yield parameters were depressed (Table 1). Boron is an essential nutrient for broccoli (Lorenz and Maynard, 1988) but this soil was able to supply an adequate amount.

Levels of B applied in this trial produced a toxic effect on HW.

Mature heads of cauliflower were harvested 25 Nov. and 4 Dec. 1987 (62 and 71 days posttransplant). Cauliflower HW, HS, and Y peaked at the 150 lb N/ac rate and produced less at the 200 lb N/ac level. Optimum N for cauliflower under the growth conditions of this trial would be less than 200 lb N/ac. Boron supplementation decreased HW, HS, and Y compared to plots which received no B.

Broccoli grown in the spring was harvested 3 and 6 May, 1988 (54 and 57 days posttransplant). Broccoli Y increased over 200% for the first 50 lb N/ac. Broccoli Y peaked at the 150 lb N/ac rate producing 382% above the 0 N plots. The broccoli gave no significant Y response to B.

Chinese cabbage was harvested 4 May, 1988 (55 days posttransplant). Chinese cabbage Y increased 110% for the first 50 lb N/ac addition and peaked at 150 lb N/ac rate with a Y depression at 200 lb N/ac. Chinese cabbage Y at the 100 and 150 lb N/ac rate was significantly higher than the 50 lb N/ac rate (Table 2). There was a significant Chinese cabbage Y interaction between N and B. Highest Y of 9300 lb occurred with 150 lb N and 1.2 lb B/ac. The 1.2 lb B/ac treatment gave a significant 14% increase in Y over no B, but the 2.4 lb B/ac rate depressed Y.

Chinese mustard was harvested 10 May 1988 (61 days post transplant). The first 50 lb N/ac gave a 50% increase in Y over no added N (Table 2). The resultant Y from 50 to 200 lb N/ac rates were equal for the Chinese mustard. The 150 lb N/ac rate significantly increased Y above the check. Boron supplementation had no significant effect on yield.

CONCLUSIONS

From the results of the Fall 1987 and Spring 1988 plantings of broccoli, maximum Y required 150 lb N/ac. Broccoli did not respond to B. This suggested adequate levels were present before soil amendment. Cauliflower gave maximum Y at 150 lb N/ac and showed depressed Y for the 200 lb N/ac treatment. Boron had no significant effect on cauliflower yield. The Chinese cabbage gave maximum Y at 150 lb N/ac and responded positively to the lower level of B. Chinese mustard gave increased Y from 50 lb N/ac.

For East Texas soils which are characteristically low in N, the four *Brassica* species grown in this soil all responded positively to this nutrient. Chinese cabbage was the only species which responded positively to boron application.

®Borate 40 is a registered product of United States Borax and Chemical Corp.

®K-Mag is a registered product of Western Ag-Minerals Company.

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Table 1. Main effects of N and B rate on head weight, head size, and yield of fall transplanted broccoli and cauliflower. 1987.

Nutrient[y] (lbs/ac)	Broccoli Avg. hd. wt. (oz)	Broccoli Avg. hd. size (in)	Broccoli Total yield (lbs/ac)	Cauliflower Avg. hd. wt. (oz)	Cauliflower Avg. hd. size (in)	Cauliflower Total yield (lbs/ac)
Nitrogen						
0	5.2 c[z]	1.9 b	1800 c	4.9 c	2.7 c	1600 c
50	9.3 b	2.6 a	3400 b	13.2 b	4.0 b	4400 b
100	11.6 a	2.8 a	4000 ab	14.1 ab	4.1 ab	5200 ab
150	11.8 a	2.8 a	4200 ab	15.6 a	4.3 a	5600 a
200	13.6 a	3.0 a	4600 a	15.3 a	4.1 ab	5400 a
Boron						
0	11.4 a	2.8 a	3800 a	13.2 a	3.9 a	4600 a
1.2	10.4 ab	2.7 a	3600 a	12.4 a	3.7 a	4200 a
2.4	9.1 b	2.4 a	3200 a	12.2 a	3.8 a	4400 a

[z]Means followed by the same letter are not significantly different at the .05% level by L.S.D. test.
[y]There were no NxB interactions.

Table 2. Main effects of N rate and residual B on yield of spring transplanted broccoli, Chinese cabbage and Chinese mustard. 1988.

Nutrient (lbs/ac)	Broccoli Yield (lbs/ac)	Chinese cabbage[y] Yield (lbs/ac)	Chinese mustard Yield (lbs/ac)
Nitrogen			
0	402 c[z]	3768 c	4272 b
50	1216 b	7894 b	6452 ab
100	1631 ab	9123 a	6071 ab
150	1938 a	9463 a	6767 a
200	1839 a	7551 b	7088 a
Boron			
0	1502 a	7293 b	6581 a
1.2	1214 a	8221 a	5794 a
2.4	1499 a	7165 b	5794 a

[z]Means followed by the same letter are not significantly different at the .05% level by L.S.D. test.
[y]There was a highly significant NxB interaction.