Project Report to the Oregon Processed Vegetable Commission-1989

TITLE: Effect of Nitrogen Sources, Calcium Rates, and Bactericides on Yield and Head Rot of Broccoli

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PROJECT STATUS: First year completed

FUNDING: $4850 from this source, $6732 other sources

OBJECTIVES:

1. To evaluate the effect of several nitrogen sources and calcium rates on yield, head rot, quality, and nitrogen content of broccoli.

2. To evaluate the efficacy of copper compounds and selected bacterial antagonists for control of broccoli head rot.

PROGRESS REPORT:

First N Source Experiment. 'Gem' was seeded on March 31 and transplanted on May 1. Treatments consisted of a factorial combination of six N sources (ammonium nitrate, calcium nitrate, urea, sodium nitrate, potassium nitrate, and sodium-potassium nitrate); two rates of total N (150 and 200 lb/A); and three rates of foliar-applied calcium chloride (0, 10, and 20 lb Ca/A). Each plot consisted of a four-row bed, 15 feet long, on 16 x 9 inch spacing. Treatments were replicated four times. Nitrogen sources were sidedressed on May 29 and again on June 13, with half the total rate applied on each date. The plots were immediately irrigated to carry the fertilizer into the soil. Calcium chloride was applied on June 13. An aqueous cell suspension of *Erwinia carotovora* (10^6 cells/ml) was sprayed onto the plants on June 17 and again on June 29. The plots were harvested on June 29 and July 7.

Neither head weight, head width, percent good heads, percent head rot, nor percent downy mildew-affected heads was significantly affected by N source (Table 1). However, the incidence of head rot tended to be lower on plots receiving either potassium or sodium nitrate. This trend, though not statistically significant, was particularly strong for the first harvest. Bead size was affected by N source, with the smallest bead size occurring with calcium nitrate as the N source, the largest with urea.

The higher rate of total N applied increased head size but also nearly doubled the incidence of head rot. At the first harvest there was a significant interaction of N rate and N source on head rot incidence: head rot increased at the high N rate for five of the six N sources, but rot incidence was lower at the high N rate with sodium nitrate as fertilizer. With potassium nitrate, the tendency for higher rot incidence at the high N rate was reduced (data not shown).

Rate of calcium chloride had no effect on head weight or quality. Leaves of plants grown with potassium or sodium in the fertilizer were noticeably darker green in color.

Second N Source Experiment. 'Gem' was direct-seeded on June 21 in 16-inch rows and thinned to an average in-row spacing of 9 inches. Treatments consisted of a factorial combination of the above N sources, with the addition of ammonium sulfate, and the same three rates of calcium chloride. Plot size was a four row bed, 20 feet in length. Treatments were replicated four times. Total N applied was split with 50 lb N/A applied on July 7, and 75 lb on both July 26 and August 21. The calcium chloride treatments were applied on August 21. Boron was applied at 2 lb/A on July 27. Cells of *Erwinia carotovora* were applied on August 21 and again on September 5. Plots were harvested on September 5 and 12.

Nitrogen source had no significant effect on mean head size, although there was a strong trend for heavier heads with urea as N source (Table 2). Yield on a ton/acre basis did vary with N source, with urea and potassium nitrate producing the highest yields. Head width also varied slightly with N source. Head rot incidence in this trial was extremely low due to the unusually warm, dry conditions during the maturation and harvest period. Neither head rot nor downy mildew incidence varied significantly with N source. Most favorable bead size occurred with sodium, potassium, and calcium nitrates. Rate of applied calcium chloride had no effect on yield or head rot.

Soil pH was affected by N source, with the potassium, sodium, and mixed sodium/potassium fertilizers increasing pH of the surface half-inch of soil and ammonium nitrate and ammonium sulfate reducing pH compared to the control value of 5.4. Sodium and potassium nitrates should reduce the amount of lime necessary to maintain adequate pH on heavily fertilized Willamette Valley soils. Leaf tissue N concentration did not vary significantly with N source or rate of Ca.

Chemical and Biological Control of Head Rot. One chemical and three biological control agents were applied in two grower fields on September 29 and October 6 (Table 3). Very little head rot developed until late in October. At this time, it was noted that the 4.0 lb/acre rate of Kocide caused phytotoxicity to the heads, expressed as a darkening and hardening of the florets. The only significant head rot development through two weeks of commercial harvests was on heads injured by the Kocide treatment.

SUMMARY:

Nitrogen source had little effect on broccoli yield at the N rates used in these trials. Differences due to N source would be expected only at rates of N less than necessary to obtain optimal yields. Calcium rate also had little effect on yield or quality. Higher rates of N, as in previous years, increased the incidence of head rot, the price one must pay for obtaining high yields. Because the amount of head rot was not high in these trials, it is hard to gauge the effect of the N sources on disease incidence. Previous work in Virginia indicated that sodium or potassium nitrates reduce head rot. The trend was the same in the first planting reported here. However, the overall head rot percentage was too low to permit definitive statements about N source effects on head rot under our conditions. Floret bead size was greatest with urea as N source, smallest with calcium and sodium nitrates.

The big surprise in the grower spray trials was the damage caused by the copper bactericide, Kocide. The floret damage caused by this material appeared to provide an entry into the plant tissue for the *Erwinia* bacterium, which was reflected in a higher incidence of head rot.

Table 1. Main effects of N source, N rate, and Ca rate on yield and quality of broccoli, July, 1989.

Treatment	Yield (T/A)	Mean head wt. (g)	Head width (in.)	Good heads (%)	Head rot (%)	Downy mildew (%)	Bead[z] size
N source							
NH_4NO_3	5.1	162	3.9	92.7	8.1	1.5	3.6
$Ca(NO_3)_2$	5.4	171	4.0	90.6	8.3	2.5	3.2
KNO_3	5.0	164	4.0	92.5	4.5	3.1	3.7
$NaNO_3$	5.4	168	4.0	92.6	5.4	1.5	3.6
$K/NaNO_3$	5.1	169	3.9	91.1	7.1	1.5	3.5
Urea	5.4	169	4.1	93.0	6.8	1.0	3.9
LSD(0.05)	NS[y]	NS	NS	NS	NS	NS	0.3
N rate, lb/A							
150	5.0	160	3.9	93.4	4.8	1.8	3.6
200	5.5	174	4.0	90.8	8.6	1.9	3.6
	**	**	**	NS	**	NS	NS
Ca rate, lb/A							
0	5.4	173	4.1	91.1	7.8	2.1	3.6
10	5.1	161	3.9	93.2	5.9	1.7	3.5
20	5.2	166	4.0	91.9	6.5	1.7	3.6
LSD(0.05)	NS	8	0.1	NS	NS	NS	NS

Notes: No significant differences in stem color or hollow stem incidence.
[z]Bead size rated on a five point scale, with 1=very fine bead, 5=very open bead, some open flowers.
[y]NS,*,**: No significant differences, significant at the 5% and 1% levels, respectively.

Table 2. Main effects of N source and Ca rate on yield and quality of broccoli, September, 1989.

Treatment	Yield (T/A)	Mean head wt. (g)	Head width (in.)	Good heads (%)	Head rot (%)	Downy mildew (%)	Bead size	Soil[z] pH	Leaf N (%)
N Source									
NH_4NO_3	4.8	166	3.6	96.1	1.3	2.6	3.3	4.8	5.41
$(NH_4)_2SO_4$	4.6	161	3.6	88.7	0.0	11.3	3.3	4.5	5.38
$Ca(NO_3)_2$	4.9	167	3.5	90.4	1.7	7.9	3.1	5.4	5.81
KNO_3	5.2	176	3.7	92.4	0.4	7.2	3.0	6.0	5.69
$NaNO_3$	4.6	162	3.6	89.9	1.7	8.6	2.9	6.2	6.16
$K/NaNO_3$	5.0	173	3.8	89.9	0.5	9.6	3.1	6.1	5.72
Urea	5.8	184	3.8	85.8	0.4	13.8	3.4	5.4	5.85
LSD(0.05)	0.5	NS[y]	0.2	NS	NS	NS	0.3	0.3	NS
Ca rate, lb/A									
0	5.0	174	3.7	88.4	1.2	10.5	3.3	5.5	5.69
10	5.0	166	3.6	90.8	1.1	8.1	3.0	NM[x]	NM
20	4.9	170	3.7	92.1	0.4	7.6	3.2	5.4	5.74
LSD(0.05)	NS	NS	NS	NS	NS	NS	0.2	NS	NS

[z]pH of the surface half-inch of the soil, September, 1989. Unfertilized soil had a pH of 5.4.
[y]NS: No significant differences among means within the column.
[x]NM: Not measured.

Table 3. Effect of Kocide and biological antagonists on head rot incidence in broccoli, October, 1989.

Treatment	Rate	Rot incidence (%) on October 20	Rot incidence (%) on October 26
Nontreated control	--	1.0	0.5
Erwinia carotovora	10^6 cells/ml	2.0	0.0
Kocide	4.0 lb/A	4.5	14.3
3832	10^7 cells/ml	0.0	1.0
3871	10^7 cells/ml	0.0	1.0
WAR60	10^7 cells/ml	2.2	5.0
LSD (0.05)		2.4	4.7

SIGNATURES:

Project Leaders: Redacted for Privacy

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Department Heads: Redacted for Privacy

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