Project Report to the OPVC - 1986

TITLE: Effect of cultural practices on yield, head rot and downy mildew of broccoli

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PROJECT STATUS: Continuing; projected completion date, 1988

FUNDING: $7500

OBJECTIVES:

1. to evaluate the effect of plant spacing on yield and disease incidence in broccoli
2. to evaluate the effect of nitrogen rate on yield and disease incidence in broccoli

PROGRESS REPORT:

1. Methods. In the spring planting, 'Gem' was transplanted on May 15, 1986. The 18 treatments included all combinations of two rates of N (200 or 300 lb/A), three between-row spacings (12, 16, and 20 inches), and three within-row spacings (8, 14, and 20 inches), resulting in nine distinct plant populations ranging from 15,000 to 65,000/A. In the summer planting (July 25), the treatments were reduced to six within-row spacings (8, 10, 12, 14, 16, 18 inches), a between-row spacing of 16 inches, and N rate of 250 lb/A, resulting in plant populations of 22,000 to 49,000/A. In both trials, the plants were irrigated daily to ensure the presence of a disease-favoring film of water on the plants for at least a portion of each day. Erwinia carotovora, the organism which produces soft rot of broccoli heads, was applied at weekly intervals to the middle rows of each plot. Heads were harvested at weekly intervals for both trials.

2. Growth and Yield. a. Spring planting. Plant growth and canopy closure were evaluated on June 6. As expected, canopy closure was earlier with the higher plant densities. This would presumably result in more favorable conditions for disease development. However, complete canopy closure occurred before head formation for all treatments.

Yields for each harvest and for the sum of all harvests generally followed the same trends. Data are shown only for the sum of all harvests (Table 1). The higher rate of N caused only a small increase in head weight and yield. The yield increase would have been enough to more than pay for the additional N fertilizer. Head weight increased, but yield decreased, with increasing space between rows or within the row. Within-row spacing had a greater effect on head size than did between-row spacing. The effects of between-row and within-row spacings on total yield were very similar. There were no statistically significant interactions between within-row and between-row spacings or between spacing and N rate. Therefore only main effects of the treatments are given in Table 1. The highest yield of 7.4 tons/A was obtained at 300 lb N/acre, within-row spacing of 8 inches, and between-row spacing of 12 inches (65,340 plants/A). Averaged over N rates, the highest yielding plant spacing was 12 inches between rows and 14 inches within-row (6.54 tons/A; 37,340 plants/A).

A more interesting way to look at the data is to plot yield versus plant population (Figure 1). Yield declines very little among populations from 65,000 to 25,000 plants/A as increased head weight makes up for the smaller number of heads harvested. Yield declined rapidly at lower plant populations.

b. Summer planting. Plant height increased as within-row spacing decreased (Table 2). Head weight increased linearly with increasing within-row spacing. The increased head size was not sufficient to offset the decrease in plant population and yield tended to decrease with decreasing plant population. The highest gross yield was obtained at a plant population of 39,200/A.

3. Diseases. Although seedlings were infected with Peronospora parasitica (downy mildew) at time of transplanting in both trials, heads were completely free of mildew in the first trial and mildew was very rare (less than 0.2%) in the second trial.

In spite of several sprays with cells of E. carotovora and daily watering, no head rot was observed in the first trial. The period between transplanting and final harvest (May 15-July 10) was very warm and dry with only 1.8 inches rainfall and 10.7 inches evaporation. Erwinia did not survive on plant leaves or heads in this experiment.

In the second trial, the six weeks following transplanting were again very warm and dry, but the weather turned abnormally wet and cool on September 8 and continued cool through the harvest period. Head rot was not present at the first harvest (September 16) but was established by the second harvest and affected a majority of heads at the last harvest. The percentage of heads affected by soft rot tended to decrease with increasing space between plants (Table 2). However, the total number of disease-free heads per plot was greater at the higher plant densities, as the larger number of heads harvested more than offset the increased percentage of head rot (Table 2).

SUMMARY

In the first trial, greater yields were obtained at 300 lb N/A than at 200 lb/A. In both trials increasing plant populations per acre decreased head size. However, yield increased slightly with increasing plant population as the greater number of heads more than made up for the reduced head size. Within-row spacing is critical as it had a greater effect on head size than did between-row spacing. In both trials the optimum plant population was between 37,000 and 40,000 plants per acre, very close to current processor recommendations. However, yield actually varied only slightly between plant populations of 65,000 and 25,000/acre, indicating a wide range of acceptable plant populations. If reduced plant populations could be shown to consistently reduce head rot, the economic tradeoff of reduced yield versus percentage of usable heads would have to be considered. In these experiments, the maximum number of usable heads in a severe head rot situation was at 37,000 plants per acre. Reducing plant populations below this level is not likely to be a cost effective means of reducing losses to head rot.

Erwinia failed to become established on the foliage prior to head formation even under relatively favorable moisture conditions. However, the

bacterium did become established on floret and stem tissue in the second experiment. This has important ramifications for spray timing as application of a bacteriocide or copper compound before head formation would not likely be cost effective.

Well water and seed were eliminated as likely sources of head rot inoculum, but surface water is an important source. Irrigation from deep wells rather than rivers would be preferred. Irrigation timing and duration remains one of the most important cultural methods that influence head rot development, since long periods of free moisture favor disease development.

Grower cultural practices will have little effect when the macroclimate is highly favorable or unfavorable for disease development. Only when conditions are marginal for disease development will plant populations, irrigation sources and duration, and bacteriocide application have any effect on head rot incidence.

The 1986 research was very successful in determining the effects of N rate and plant spacing on yield, but was only partially successful in determining the effects on head rot and downy mildew. Although unusually warm (spring planting) and unusually cool, wet (summer planting) weather affected head rot incidence, valuable information was obtained on Erwinia survival in the broccoli plant environment.

Table 1. Main effects of N rate, between-row spacing, and within-row spacing on canopy closure, head size, and yield of broccoli, sum of all harvests; spring planting, 1986.

Treatment	Canopy closure[z]	Mean head wt. (lb.)	Mean head width (inches)	Yield (tons/A)
N rate:				
200 lb/acre	2.3	0.46	3.9	5.83
300 lb/acre	2.2	0.50	4.1	6.28
	NS[y]	*	NS	NS
Between-row:				
12 inches	2.8	0.44	3.9	7.16
16 inches	2.2	0.48	4.1	5.91
20 inches	1.6	0.51	4.2	5.48
	*	*	*	*
Within-row:				
8 inches	3.3	0.37	3.6	6.31
14 inches	2.3	0.50	4.2	5.94
20 inches	1.2	0.56	4.4	5.25
	*	*	**	*

[z] 5 point scale with 5 = complete coverage, 1 = ground showing within and between rows.

[y] NS, *, **: no significant differences, differences significant at 5% and 1% levels, respectively.

Table 2. Effect of within-row spacing on broccoli plant height, yield for the sum of three harvests, and head rot incidence; summer planting, 1986.

Within-row spacing (inches)	Plants/ acre	Plant height (inches)	Mean head wt. (lb)	Yield (tons/A)	% rotten heads	No. of usable heads/plot
8	49,005	15.2	0.44	6.76	39	20
10	39,204	13.9	0.48	6.83	27	23
12	32,670	13.8	0.46	6.01	23	22
14	28,003	13.1	0.52	5.29	22	18
16	24,503	12.9	0.49	4.78	18	17
18	21,780	12.2	0.58	4.91	29	12
	linear	**[z]	*	NS	NS	
	quadratic	NS	NS	NS	NS	

[z]NS, *, **: no significant differences among means, significant differences at 5% and 1% levels, respectively.

Figure 1.