Galactinol-Weight Relationships in Breeding for Resistance to the Sugar Beet Nematode

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The control of the sugar beet nematode (Heterodera schachtii) has become a serious problem of universal interest wherever sugar beets are grown. It has been felt that the best solution of this problem would be resistant varieties.

Progress reports of breeding for resistance to this pest have been given by Rietberg (4, 5)[2] and Swink (6). The breeding procedures used were to index and then to select the best appearing plants which were exposed to a severe infestation of nematodes.

Breeding resistant varieties would be easier if certain chemicals were known which would keep the eelworms from entering and feeding on the sugar beet roots. In 1922 Baunacke (1) suggested the possibility of isolating some chemical substance in the root secretions which would stimulate the cysts to hatch. Wood and Serro (7) made qualitative tests on concentrated root diffusates. They found three chemicals i-inositol, galactinol and glutamic acid which constituted the major portions of the exudate from nematode host plants.

Bauserman and Olson (2) tested various pure chemicals with respect to their influence on the hatching of the eelworms from the cysts. They concluded that galactinol, glutamic acid, glycine, and sucrose appeared to enhance the emergence of eelworms from cysts.

Chemical determinations of many of the above mentioned compounds have been made on strains which were phenotypically selected as being slightly resistant to nematode. As a result of the analysis in 1954, Finkner and Swink (3) reported an interesting galactinol-yield relationship.

The 1954 test was conducted on material that had been selected for tolerance to nematode in previous years. The test was set up in a triple-lattice design of 16 selections with single row plots 15 feet long.

The selections in the replicated plot test were very severely damaged by nematodes and many lines were nearly completely eliminated. However the data showed a definite differential reaction among the selections for yield under conditions of high nematode infestation.

The most interesting observation coming from the data of this test was the inverse association of galactinol with yield. The same relationship also was true when the three different strains from the border rows were sampled.

Hybrid XXIII appeared extremely susceptible to nematode and because of its high galactinol content this strain was chosen as a susceptible check for further tests.

Methods and Materials

The best roots from the 1954 plot tests were saved as mother beets. These were planted in the greenhouse for seed production before the

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[2] Numbers in parentheses refer to literature cited.

galactinol-weight relationship was discovered. The plants were allowed to interpollinate at random, but the seed was harvested by individual plant (M lines).

The seed production was quite limited from some individual plants, therefore, the number of plots planted varied from one up to nine plots. All of these seed lots, including 13 plots of the susceptible check, Hybrid XXIII, were planted at random in the 1955 nematode nursery. The plot size was single rows, 20 feet long, and all beets at harvest time were sampled for chemical analysis.

Results and Discussion

Good stands were obtained in the majority of the M lines and check. However, the growing conditions were not as favorable in 1955 as in 1954 because of drought conditions, especially in the latter part of the season. If the growing conditions had been more desirable a greater spread probably would have developed between the selections and the check. The check, however, appeared good throughout the growing season.

The yields were very low in all sections as shown in Table 1. However, it was noted that the relationship of galactinol and yield was much the same as was found in 1954.

Table 1.—Average Yield, Chemical Content and Number of Roots from Two or More Plots of Different Selections Grown in a Nematode Nursery.

Pedigree Number	Description	Lbs. Beets Per Plot	Percent Suc.	Percent Gal.	Percent Raff.	Total No. Plots	No. of Beets
4-3	Nursery Selection of 52-413	12.43	14.97	.030	.097	3	13.00
1-13	Line 3458-2	11.50	15.65	.045	.070	2	19.00
1-9	Line 3458-2	9.90	15.75	.035	.095	2	17.50
1-15	Line 3458-2	9.30	15.60	.045	.125	2	13.50
1-1	Line 3458-2	9.00	15.17	.040	.063	3	12.33
2-2	Line 3461-2	7.05	13.60	.040	.110	2	11.00
52-413-6	Field Selection of 52-413	6.90	13.20	.068	.084	5	7.00
52-413-2	Field Selection of 52-413	6.33	12.78	.076	.079	9	12.89
52-413-5	Field Selection of 52-413	6.10	10.15	.065	.055	2	15.50
8-4	Line 3493-1	5.33	14.77	.117	.097	3	15.00
Check	Hybrid XXIII	4.65	11.12	.078	.079	13	13.62
1-3	Line 3458-2	4.63	14.57	.100	.103	3	12.33
2-1	Line 3461-2	3.93	14.17	.080	.117	3	7.33
1-16	Line 3458-2	3.60	14.65	.100	.085	2	10.50
4-4	Nursery Selection of 52-413	2.94	13.60	.104	.106	5	3.80
	General Mean	6.91	13.98	.068	.091	3.9	12.29

The major part of the selections in this test were from individual roots from strains which ranked high in the 1954 test. Although the seed of these M line selections were all open pollinated, they tended to group closely to one another when they were from the same parent.

For example, the grouping of the "1" M lines which ranked 2nd, 3rd, 4th, and 5th were all from selection 3458-2. Two other M lines from this same parent selection ranked low. The "M" line progenies from the commercial field selection of 52-413 all ranked together around the general mean.

Figure 1.—Three top ranking progenies from the parent root 3458-12. Left to right: 1-15, 1-13 (in front of person) and 1-9.

The big exception to this trend was the "4" M lines. Selection 4-3 was the top ranking selection while its sister line 4-4 was the bottom ranking selection. Some segregation also should be expected in this material as all of it was open pollinated seed.

Three of the top yielding "1" lines from the parent root 3458-2 are shown in Figure 1.

The degree of tolerance of some of the selections expressed under extremely heavy infestations of nematode are shown.

Table 2 shows the results of some of the selections where only one plot was available for harvest. Again it brings out the same trend of galactinol and yield as mentioned in the previous discussion.

Table 2.—Yield, Chemical Content and Number of Roots from Single Plots of Different Selections Grown in a Nematode Nursery.

Pedigree Number	Description	Lbs. Beets Per Plot	Percent Suc.	Percent Gal.	Percent Raff.	No. of Beets
1-4	Line 3458-2	16.7	15.5	.020	.120	20
4-1	Nursery Selection of 52-413	15.7	14.5	.020	.050	13
8-1	Line 3493-1	10.6	14.3	.040	.130	11
1-10	Line 3458-2	4.5	16.5	.050	.120	5
1-7	Line 3458-2	2.5	16.9	.060	.080	4
1-12	Line 3458-2	1.8	15.5	.100	.150	3
8-2	Line 3491-1	1.6	15.1	.070	.130	2
52-413-4	Field Selection of 52-413	1.6	16.6	.010	.130	1
3-1	Line 3461-3	1.1	15.7	.070	.090	2
4-2	Nursery Selection of 52-413	0.6	13.9	.150	.120	1
1-5	Line 3458-2	0.4	12.3	.160	.130	1
1-6	Line 3458-2	0.4	11.6	.170	.110	1
	General Mean	4.79	14.87	.077	.113	5.33

The number of beets per plot in this table played a large part in the yield of each selection. The rank in yield very closely corresponds to the total number of beets harvested. The galactinol ranking falls into line very well, with the exception of one line 52-413-4. The fact that only a single root remained at harvest time no doubt has caused that misplacement. However, this root was very outstanding.

Summary and Conclusions

An inverse association between weight of beets and galactinol content has been found during the last two years of testing nematode selections in a diseased nursery. This would indicate that galactinol may be of value as a chemical characteristic in selecting beets resistant to this pest.

Because of these findings further tests of selections for various amounts of galactinol content are being conducted.

References

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