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PROBLEMS IN GROWING VEGETABLES FOR CANNING AND FREEZING

by

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Foreword

The early history of the vegetable canning industry of Oregon reports that the first commercial pack of any proportion occurred in 1919 with a total of 82,579 cases. This amount was made up of beets, cabbage, carrots, corn, pumpkins, spinach, snap beans and tomatoes. In 1940 the total pack of some twelve vegetables amounted to 3,676,442 cases, having a valuation of approximately $5,000,000.

The increase in volume of business has been even more significant in the industry of preservation by freezing. In the northwest, freezing operations began in a small way in 1934. In 1937 twelve or more vegetables were frozen and the pack for Oregon-Washington exceeded forty-four million pounds in 1941.

It seems certain that under the existing emergency conditions several vegetable crops will be processed by dehydration during the coming season.

What have been the factors that have induced such an increase in volume of business? Briefly, they may be summarized as follows:

(1) Favorable environmental conditions for vegetable culture, including moderate temperatures for crop production, extensive areas of good land, abundant sources of water, and modern methods of irrigation.

(2) Solution by the Oregon Experiment Station, seed breeders and processing companies of problems encountered in the production of certain crops, such as beans, beets, peas and others.

(3) Adherence of canners and freezers to high standards of pack, thus firmly establishing the reputation of the state for canned and frozen vegetables.

(4) Widened distribution of pack.

The general culture of individual crops grown for canning and freezing is discussed in various publications of Oregon State College listed in the bibliography of this bulletin.

This publication deals particularly with the problems of production that have been under investigation during the past several years.

OREGON CANNED PACK OF VEGETABLE CROPS

1919-1940, inc.

Total Cases of all Sizes (24/2s)

	1919	1930	1940
Asparagus	--	--	24,455
Beet	3,608	120,148	321,504
Carrot	2,650	137,137	246,378
Corn	1,034	5,482	93,288
Pea	--	--	1,255,501
Pumpkin	12,574	197,436	199,216
Snap Bean	31,578	225,544	1,282,620
Tomato	21,351	45,816	91,807
Tomato Juice	--	--	41,952
Miscellaneous	7,602	1,729	36,263*
Total	82,579	797,384	3,676,442

* Subject to slight revision due to figures of some crops not available.

VEGETABLES GROWN FOR FREEZING PRESERVATION IN THE NORTHWEST*

FOR YEARS 1934-40 INCLUSIVE

Pounds

	1934	1935	1936	1937	1938	1939	1940
Asparagus				910,090	1,719,015	1,766,349	1,869,846
Beans, lima				149,356	247,461	130,048	598,720
Beans, snap	250,000	1,000,000	1,930,000	2,244,195	3,185,600	1,584,321	1,160,122
Broccoli				519,102	983,097	1,006,085	603,130
Brussels sprouts				188,780	375,975	410,070	502,168
Carrots				81,703	13,878	10,795	14,668
Cauliflower				237,413	418,935	715,346	566,489
Corn, cut	500,000	1,000,000	1,270,000	1,777,219	2,749,091	658,433	1,765,011
Corn, on cob				453,215	842,960	611,600	913,870
Peas	1,750,000	4,000,000	8,220,000	10,982,166	15,760,841	10,258,885	17,729,700
Peas and Carrots				62,808	536,829	240,815	172,489
Spinach				792,659	1,324,602	2,104,239	2,572,957
Squash				407,087	715,047	806,121	589,349
Miscellaneous	500,000	1,000,000	1,050,000	-	786,891	1,529	21,000
Total	3,000,000	7,000,000	12,470,000	18,805,793	20,660,222	20,304,636	29,079,519

* Figures are for Oregon-Washington. Data for individual states not available. Data from Western Canner and Packer.

PROBLEMS IN GROWING VEGETABLES FOR CANNING AND FREEZING

Asparagus. The canned pack of asparagus for 1941 in Oregon and Washington was approximately 303,386 cases, and more than 3,400,000 pounds were frozen.

Plants grown from selected strains of seed produce spears that are straighter, more uniform in shape and color throughout the field, more compact in tip formation and more productive in yield than plants grown from unselected seed strains. The variety most widely grown is Mary Washington.

Damage to asparagus which affects the appearance and grade of the spears is caused by (1) asparagus beetles, (2) crooked stalks induced by slugs or beetle bites, (3) symphylids.

Poultry will eat the beetles without damaging the spears and, therefore, commercial asparagus growers allow chickens to feed in the asparagus area. Slugs can be controlled by standard baits such as suggested in O.S.C. Extension Bulletin 551. (18)* No reasonable economical control methods are yet available for symphylids.

Asparagus spears change rapidly in composition after cutting. Toughness caused by ligneous fiber begins at the basal end and extends upward. Rapidity of this fibrous growth is prevented to a large extent by precooling after cutting and quick delivery to the processing plant.

Most of the asparagus raised in the Northwest for canning and freezing is of the "all green" type.

Snap Beans. Oregon's canned pack of beans in 1941 exceeded a million and three-quarter cases and more than a million pounds were frozen packed. Over 2000 acres were required to produce the crop.

Investigations of problems of beans grown for canning and freezing have included tests of seed strains, observations of blossom drop, malformed pods and methods of beetle control.

The variety grown most widely for canning and freezing is Blue Lake, of which there are several strains, varying in season, plant growth and type. The early Blue Lake strain is earlier in blossoming and pod production but produces less foliage and shorter pods. The later strains produce more foliage and stool out more at the base of the plant. Some strains of Blue Lake have been developed that are entirely stringless at any stage of development but these may lack some other necessary character. Strains of unusual length have been originated but they are generally not adapted to the snipping equipment now in use.

Malformed pods, sometimes called "polliwogs," occur not infrequently when there is insufficient pollination and lack of seed development in the pods. It is known that pods may develop this undesirable character because of high temperatures that interfere with pollen germination. It has also been observed

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* See List of References page 10.

in field trials that "polliwogs" may occur on plants growing in impoverished soils or those insufficiently fertilized and watered.

Probably the greatest single source of injury to pods is caused by the 12-spotted beetle, present recommended control measures for which are stated in Extension Bulletin 551. Studies of the feeding habits of this insect and the efficiency of control materials are being continued by the Oregon Experiment Station.

Mosaic has at times caused severe injury to Blue Lake beans. No mosaic-resistant strain of Blue Lake is yet available, although progress is being made in this direction. Red clover is known to be a carrier of the yellow mosaic of bean and therefore beans should not be planted adjacent to red clover fields if this can be avoided.

Symphylids are also injurious to bean seeds and the roots of plants but as yet no satisfactory control measure is available.

Rust, a fungous disease, was extremely injurious in 1941 and the Blue Lake variety appears to be quite susceptible. Thus far, attempts to control this disease by the use of fungicides other than fine dusting sulfur have not been successful. Rust rarely appears in seasons of average humidity and rainfall.

Lima Beans. Varieties of lima beans grown most widely in western Oregon have been either the Henderson bush or Fordhook.

Seed treatment with certain protectants has assisted in preventing seed rot, thereby obtaining a higher percentage of germination, a better stand of plants, and an earlier growth toward maturity.

One of the chief problems in growing green-shelled lima beans is that of obtaining a satisfactory yield per acre. Low yields are due to soils of low fertility or low moisture content or to an excessive foliage growth of the plant due to a high nitrogen content without sufficient phosphorus. In addition to these factors, low yields are due to blossom drop, which may be serious in some seasons. From investigations made concerning the failure of flowers to set pods, high air temperature and low relative humidity seem to favor dropping of blossoms.

Contrary to the experience in the growing of green snap beans, irrigation of lima beans in western Oregon is not generally advisable. It may increase the total yield of beans but it may likewise prolong the growing season, in which case there would be beans on the vine in all stages of maturity. This uneven ripening is objectionable when the vines are put through the viner. Also, the harvesting stage of the pods may be retarded by the use of water, and this may delay harvest until the time of frost.

Beets. Practically all of the beets grown in Oregon are produced for the canning trade. Over 800,000 cases of beets were canned in 1941. Detroit Dark Red is the most widely grown variety. In the earlier days of beet growing and canning in the state, tests were made at the Oregon Experiment Station of a

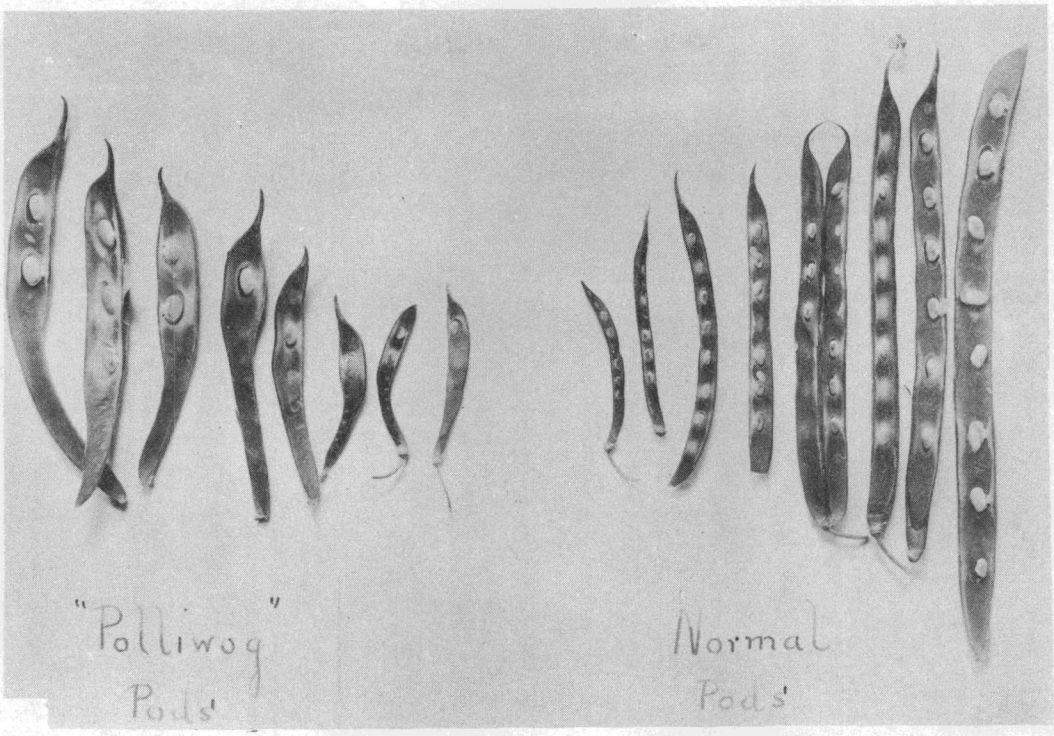

Fig. I Pods on right have been properly pollinated. Seeds have been fertilized and pods have made normal development.

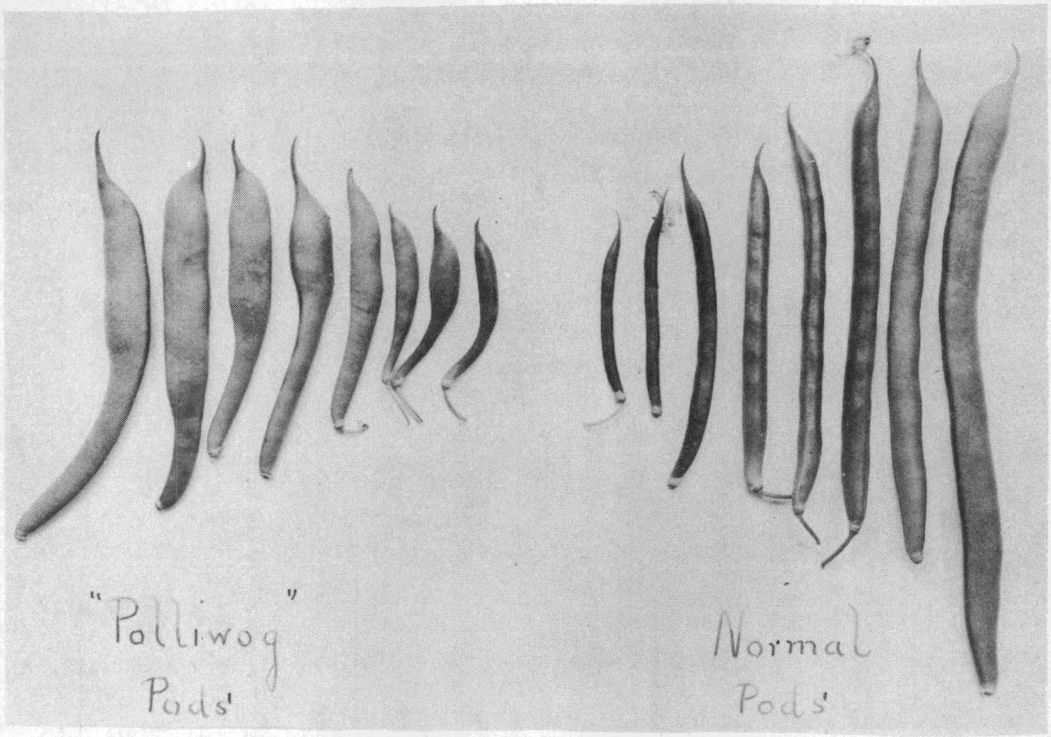

Fig. II "Polliwog" pods are under developed and malformed as indicated in figures I and II.

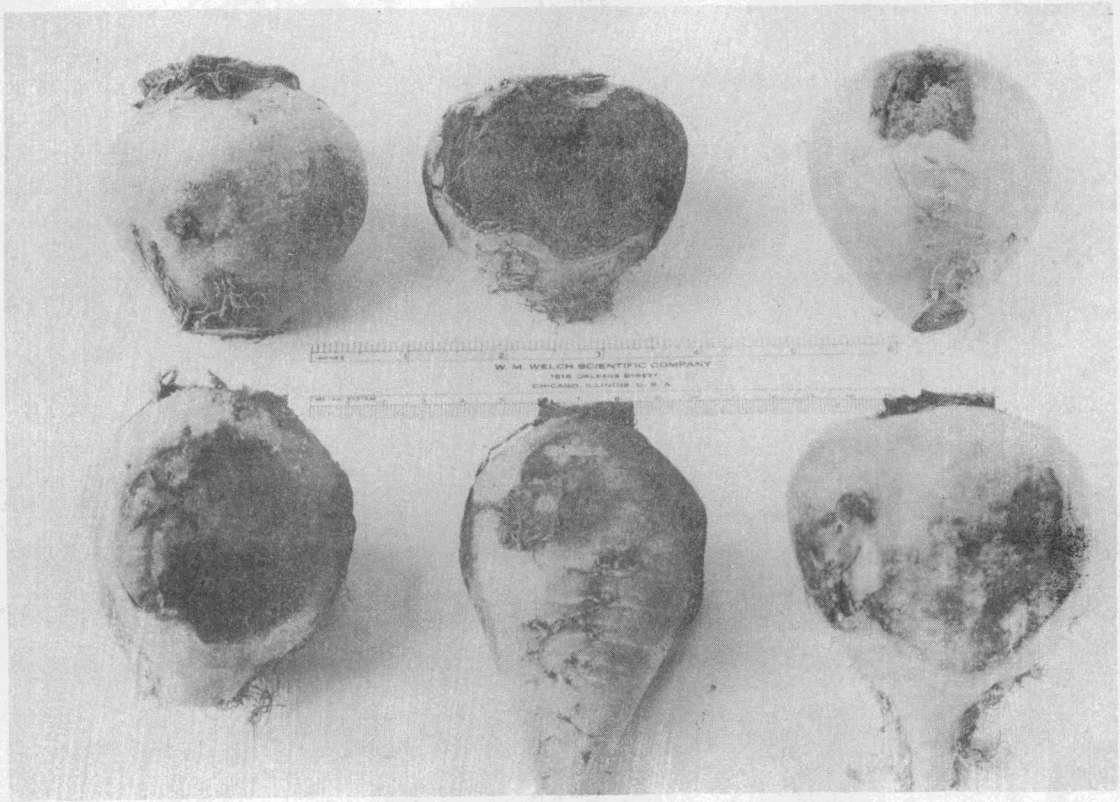

Fig. III External appearance of roots varying in degree of canker.

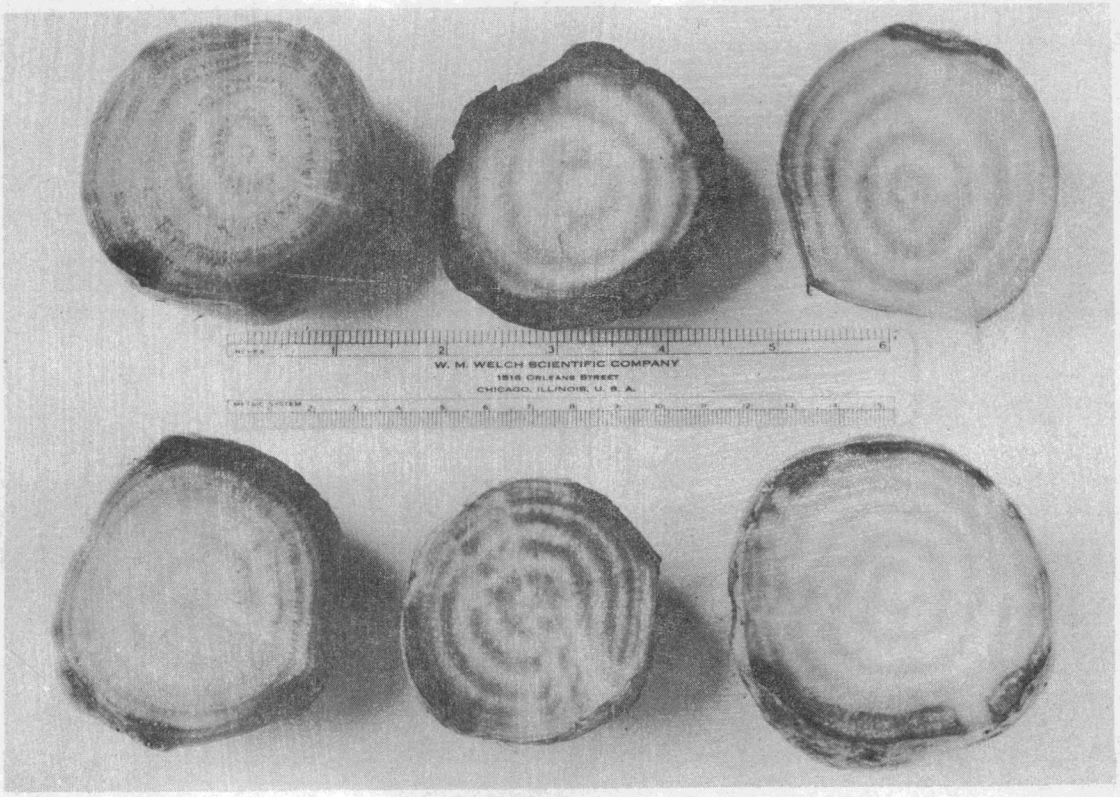

Fig. IV Internal appearance of same roots showing varying degree and depth of canker.

number of strains of Detroit Dark Red, mainly for observation of desirable color and form. These characteristics of the beet no longer seem to be major problems or of unusual concern to growers and packers. The leading strains of Detroit Dark Red are generally of good form and color.

To make a good canning beet, the variety and strain should produce a root of good color, shape and quality, and be free from any definitely apparent zoning. The strain should have high resistance to downy mildew which can be very injurious under certain seasonal conditions. Certain strains of Detroit Dark Red are quite resistant to this disease and some strains, also, seem to be more highly resistant to injury caused by boron deficiency than other strains. These, however, may not meet all the requirements of a good canning beet.

In recent years, two problems have presented themselves to beet growers: (1) canker, black spot or internal breakdown, which is now controlled by applications of borax; and (2) downy mildew, a fungous disease.

The value of boron in controlling canker of table beets was first presented in 1939 in Circular of Information 195 of the Oregon Experiment Station. Newer developments in the use of this minor plant food element are discussed in Station Circular of Information No. 248. (3) At the present time, practically every beet field in Oregon which has shown signs of canker on the roots is receiving applications of borax every two or three years, at least, up to 50 pounds of borax per acre.

Downy mildew is being controlled largely by the use of strains of Detroit Dark Red that are resistant to the disease.

Broccoli. This vegetable is grown most widely for preservation by freezing. During the last few years, the amount delivered to factories in Oregon and Washington has been over 1,000,000 pounds. Investigations of cracks or splits on the underside of the edible stems indicate that these are due to the plants growing in soils deficient in boron. The use of 10 to 25 pounds of borax included in the commercial fertilizer mix is now a standard practice in growing broccoli in Oregon.

An important problem in growing broccoli is that of controlling aphids, the control of which necessitates the use of dust, made up of five per cent nicotine sulfate and activators. Possibly five or more dustings are necessary.

Brussels sprouts. This vegetable was frozen in the Northwest in 1941 to the extent of over 1,000,000 pounds, which was about two-thirds of the national crop preserved in this manner. This is another member of the cabbage tribe which has shown symptoms of boron deficiency in soil. The symptoms do not show as rapidly as on broccoli; nevertheless, there may be swellings on the stems, and the leaves at the base of the plant fall off and the sprouts are usually smaller, according to the symptoms described by Chandler. (5) Commercial growers of Brussels sprouts in Oregon are including borax up to 25 pounds per acre in their commercial fertilizer mix.

Dusting for control of aphids is virtually similar to that used for broccoli.

Carrots. The average yearly pack of Oregon carrots amounts to between 250,000 and 300,000 cases, or about one-fifth of the total national pack. Carrots also figure in a minor degree in the extraction of juice and in freezing, both alone and in combination with other vegetables, such as peas and carrots. Carrot juice, at the present time, probably ranks second to the tomato among unmixed vegetable juices.

Since 1940 carrots have shown symptoms of breakdown quite similar to those exhibited in other roots, such as beets, turnips and rutabagas. Thus, the important maladies of carrots at the present time are exterior canker, black heart and hollow heart, as well as cracking and watery core.

There are strong indications that these characters, particularly those showing breakdown of the pith or core of the root, may be prevented by the use of 20 to 30 pounds of borax per acre, boron being known to be an essential element for carrots according to Warrington (7).

Cauliflower. This is also an important vegetable for freezing in the Northwest, and was preserved to the extent of 1,500,000 pounds in 1941.

The two outstanding symptoms of deficiency of boron in cauliflower are: (1) the watery or brown stem which is oftentimes hollow; and (2) the discoloration of the curd or head. As little as five and six pounds of borax per acre have been used in New York State to successfully control the discoloration and brown rot of cauliflower heads. In Oregon cauliflower fields, thus far, 20 pounds of borax have been included in the complete fertilizer mix used for the crop.

Celery. Several thousand cases of celery juice have been canned annually in Oregon. Most of the celery grown for juice has been of the green type - Pascal or Utah. Problems connected with celery production have involved the control of stem crack and late blight.

When celery stem crack first became noticeable in the state, samples of borax were sent to growers whose plants were affected. Trial applications of borax were also made on celery at the Oregon Experiment Station on land that had been farmed to field crops for a number of years. Stem crack affecting plants on this land was controlled by the application of 20 pounds of borax. Since that time virtually all celery growers in Oregon have used at least 20 pounds or so of borax biannually.

Severe epidemics of late blight occur at infrequent intervals, and in such cases, ordinary methods of control may be ineffective. In average seasons, however, applications of Bordeaux mixture with a spreader are usually satisfactory.

Peas. The acreage of green peas for canning and freezing has increased more rapidly than that of any other single crop. Data in the tables of this bulletin indicate how rapidly the volume of green peas has increased since 1934.

The most important single factor contributing to the successful production of canning and freezing peas, based on the extent of acreage devoted to the

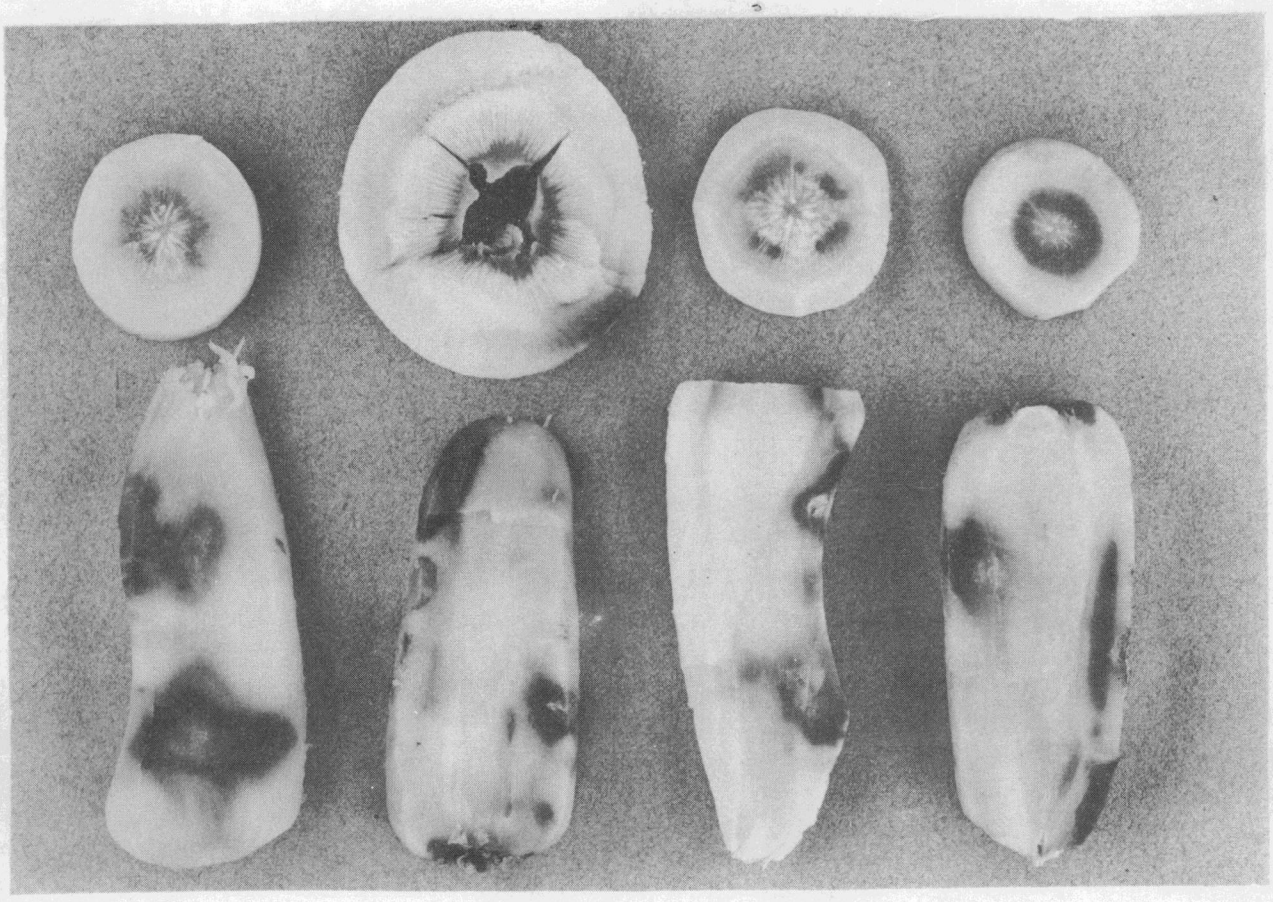

Fig. V Various forms of interior blackening and breakdown of carrots.

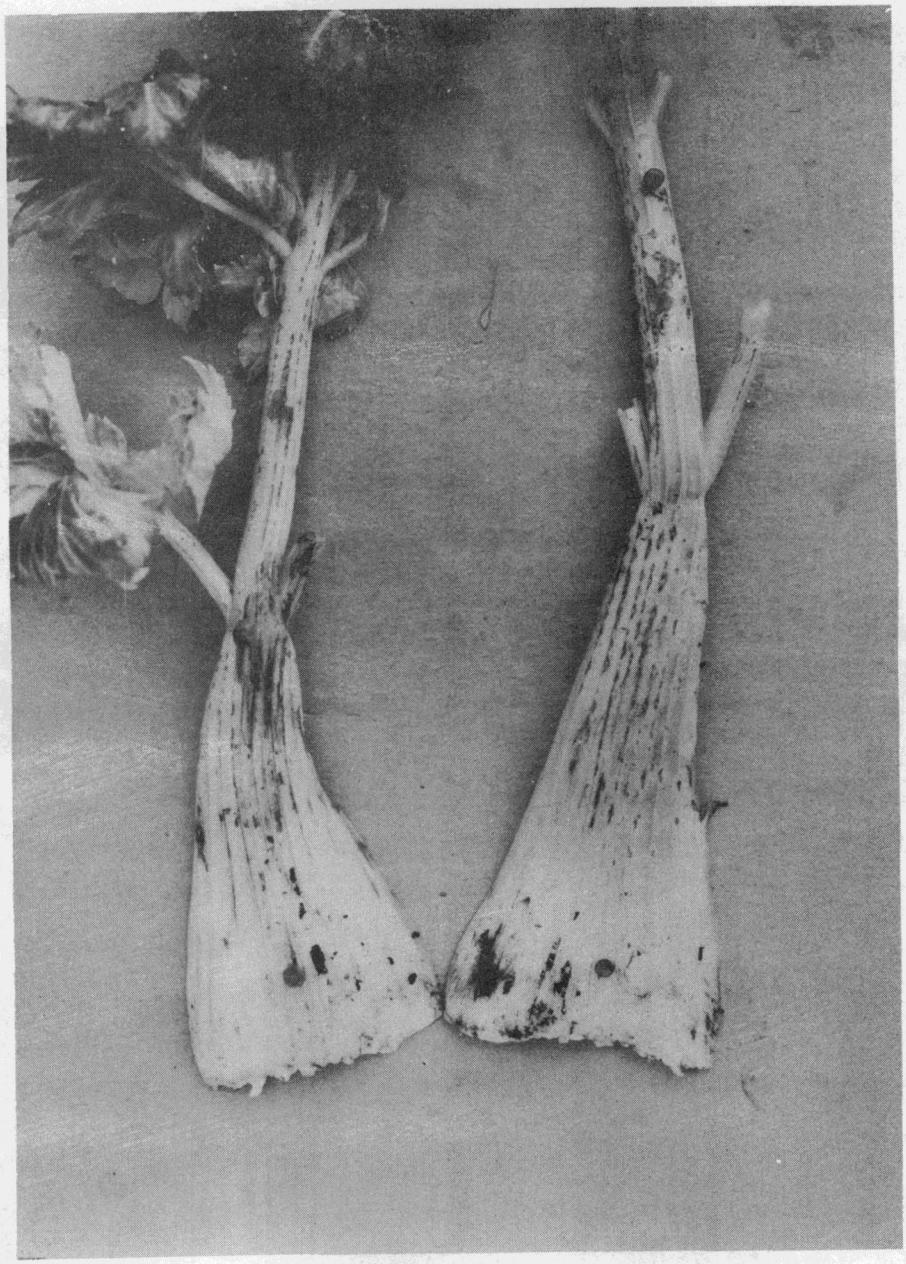

Fig. VI Stalks of celery showing crack on ribs the full length of the stalk. Leaves of plant on left are dwarfed and curled.

crop, has been the control of the pea weevil, recommendations for the control of which are discussed by Chamberlin and Gray (9).

Another important contribution is that involving the control of the pea aphid, a serious insect pest of the pea plant, particularly in Western Oregon. Studies by Gray and Schuh (10) indicate the usefulness of a dust containing rotenone .75 per cent and soyabean oil 3 per cent. It is important that aphids be fully controlled not alone to prevent injury that these insects may do to the plants themselves but also to prevent the plants from becoming affected with serious virus diseases, such as mosaic, which is spread by aphids.

Data accumulated over a number of years at the Oregon Experiment Station emphasize the desirability of pea seed treatment, particularly in the areas of the state where there is considerable rainfall during the seeding period. The use of red copper or organic mercury dusts on the seed prior to planting has greatly increased the percentage of seed germination, reduced the necessary amount of seed planted per acre, improved the stand and growth of plants and contributed towards a more healthy and enlarged root system. The more moist the season of the year when seeding is done, the greater is the effectiveness of the materials in protecting the seed from rot. To prevent friction in drills, one-half pound of finely powdered graphite should be mixed with each pound of seed treatment material.

The required characters of a variety of pea for canning and freezing are (1) desirable green color of the shelled pea, (2) productiveness, (3) good edible quality, (4) pods concentrated as much as possible in season, (5) resistance to wilt wherever such disease may be prevalent.

Differences in these characters vary not only among varieties themselves but also among strains of the same variety as is evidenced in comparing the results of strain trials.

The variety which has proved most satisfactory for freezing and which is being most widely used in commercial plantings is Thomas Laxton. Perfection is mostly used in the growing of peas for canning.

Spinach. Experimental field tests at the Oregon Experiment Station and in commercial fields have indicated the desirability of treatment of spinach seed prior to planting. Red copper compounds are effective in preventing seed rot and induce a uniform stand of plants resulting in increased yields. When the seed is planted with a drill, one-half pound of finely powdered graphite should be added to one pound of red copper oxide per 100 pounds of seed.

Mercury compounds have likewise been useful in treating spinach seed and in increasing tonnage per acre. Zinc oxide is also effective as a seed dust, to which graphite should likewise be added.

Trials in the experiment station grounds of the use of 20 pounds of borax included in the fertilizer mix have increased yields of spinach up to 64 per cent. These results are in line with those reported by Cook and Millar (13), who report that 10 pounds of borax increased yields of spinach by 70 per cent. Larger applications than 20 pounds per acre did not cause further increase in

yields. These authors state that the boron deficiency symptoms in spinach were found to be almost identical with symptoms of heart rot in sugar beets. This is not surprising since the two plants are very closely related in the same family.

Giant Nobel, a smooth-leaved variety, has been most widely used for canning and freezing.

Sweet Corn. This vegetable is highly important in both the canning and freezing industries of the state. Oregon-canned corn has amounted to about 100,000 cases annually in recent years, while over $2\frac{1}{2}$ million pounds of sweet corn were delivered to freezing plants in Oregon-Washington in 1940.

For a number of years, varieties of sweet corn have been under observation in the Oregon Experiment Station gardens. In 1933, some commercial growers of the state were urged to try some of the newly-introduced hybrid strains of sweet corn, including Golden Cross Bantam, which despite hundreds of other hybrids later introduced by the seed trade, still remains predominant as the most satisfactory main crop variety.

Since its introduction, Golden Cross Bantam (P. 39 x P. 51) has been most satisfactory because of its uniformity in size and shape, color and quality. The greater part of the acreage of sweet corn in the state for freezing and canning is planted to this variety. Strains of Golden Cross Bantam vary in several characters such as color of tassels, size of ears, size of cobs, shape of kernels and tightness of husks. Small cobs, compared with the size of the ear, twelve rows of kernels, and tight husks enfolding the ear are desirable.

Earlier varieties of hybrid sweet corn have been less uniform and productive in yield than Golden Cross Bantam. They seem, also, to be more susceptible to attack of 12-spotted beetles and corn ear worm and thus far few, if any, of the earlier varieties have met with the approval of processors.

Ioana (IP 39 x I 45) is a useful late variety and seems to have some greater degree of resistance to ear worm. Tendergold (Golden Sunshine x P 39) has been a satisfactory second early variety preceding Golden Cross Bantam by some ten days or so. Hybrid 92-28 has yielded ears that are uniform in shape, number of rows of kernels, and color. This hybrid is productive and of good quality.

Aristogold produced a large ear more suitable for cut corn than for freezing. Goldenwood, a 12-row ear of good color, appeared promising. Goldbred has good color but is variable in type. Magnagold, with rows varying from 16 to 20, showed good color and straight rows. Carmelcross has good color and 12 rows of kernels but ears were somewhat uneven and kernels broad and medium deep. Seneca Golden has been inconsistently good, its main virtue being its earliness. It has yielded well in small field trials but has not been so satisfactory in commercial plantings. Bantam Evergreen hybrids have been productive and of good color and quality. Ears are moderately large and mostly 12-rowed.

Table I. Comparison of Varieties of Sweet Corn 1941

Variety	Seedsman	Days Seeding to Harvest	Mean Weight Ears oz.	Mean No. Ears Per Plant	No. Rows Kernels	General Characters
Golden Cross Bantam*	A,B,C,D	102-5	11.5	1.8	Mostly 12	Present standard of quality.
Extra Early Bantam	A	88	5.6	1.4	8	Satisfactory for small ear, light yielder.
Seneca Golden	A	88	8.9	1.8	Mostly 12	One of the better early varieties.
Carmelcross	F	90	10.0	1.4	12-14	Good color, not very uniform.
Carmelcross 39.13	B	88	9.3	1.8	12-14	Very similar to above.
92 x 28	A	98	11.0	2.0	Mostly 12	Good appearance, deep color, good quality.
Early Tendercross	B	88	8.8	1.2	10-12	Early, not productive, color only fair.
Tendergold	C	97	10.9	1.6	12	Earlier than Golden Cross but not as productive.
Tendergold	G	101	11.4	1.2	12	Uniformity not as good as Golden Cross.
Goldenwood	C	100	11.2	1.9	12	Good appearance and color somewhat variable.
Early Bancross 39	C	97	8.1	1.0	8-10-12	Fair color, ear not attractive, unproductive.
Aristogold 1	G	110	12.0	1.1	12	Large, good color, late season.
Aristogold 2E	G	115	16.0	1.1	16-18	Large ears, fine kernels, rather light color, late season.
Spancross 13.4	B	88	9.4	1.1	8-10	Early, mod. small, unproductive.
Spancross	F	87	8.4	1.0	10-14	Early, larger type, unproductive.
Bantam Evergreen Hybrid	C	100-107	9.4	2.0	12-14	Productive, good color and quality.
Magnagold	F	105	16.0	1.8	16-18	Large, good color, productive, promising for large ears.
Marcross	F	89	14.3	1.0	10-12-14	Early but not attractive, not productive.
Goldbred	G	111	25.6	1.1	12-14-16	Good appearance, somewhat variable, late season.
Earligold	C	87	10.0	.82	10-12	Too light in color, ears not well filled, unproductive.
Whipcross	C	98	10.5	1.5	12	Color only fair, rows not straight, not attractive.

* Mean 4 strains

Table II. Comparison of Strains of Golden Cross Bantam Corn 1941

Strain	No. ears produced	Total weight ears		Mean weight per ear	Ears		No. ears per plant	No. rows kernels per cent
		lbs.	oz.	oz.	Length in.	Circum. in.		
A	209	157	0	12.0	8.0	1.8	1.9	72 - 12
B	205	150	0	11.7	7.4	1.6	1.9	68 - 12
B	229	153	0	10.6	8.0	1.7	2.0	70 - 12
C	162	105	0	10.3	8.0	1.7	1.5	76 - 12
C	175	110	0	11.1	8.0	1.7	1.6	71 - 12
C	219	152	0	11.1	8.2	2.0	2.0	75 - 12
D	179	129	0	11.5	8.0	1.8	1.7	68 - 12
D	174	117	0	10.7	9.0	1.5	1.6	69 - 12

Two insects oftentimes do much damage to sweet corn. The 12-spotted bean beetle feeds on the silks of the ear, thereby preventing proper pollination of the silks. The corn ear worm is usually present in almost every sweet corn planting and the damage done to ears is dependent on the extent of the infestation in the field, the time of the injury and the characters of the variety.

The control of either of these insects is difficult. The 12-spotted beetle can be repelled or driven off by the use of dusts such as calcium arsenate on the silks. Repetitions of dustings will be necessary to keep the beetles from injuring the silks.

Materials for possible control of the corn ear worm include calcium arsenate, various fluosilicates, and mineral oil containing pyrethrins. In contrast with the dusts such as calcium arsenate and the fluosilicates which can be used as soon as the silks appear, the oil treatment should not be made until the silks have been pollinated. Special oiling equipment is on the market for making the injections of oil into the tips of the ears so that only a specified amount of oil is applied to each ear. (18)

Tomatoes. Trials of tomato varieties have been carried on for several years. No outstanding variety suitable for canning has yet been found. An early ripening variety must be grown in the Willamette Valley in order that sufficient tonnage be produced to make tomato growing profitable. In Southern Oregon where seasons are warmer, later maturing varieties which are productive of greater tonnage per acre can be grown satisfactorily.

A variety of tomato for canning should be early, productive, medium-sized, round, smooth, fairly solid to solid, of good uniform color and having no green color about the stem if possible.

Tomato varieties best suited for canning in western Oregon (Willamette Valley section) include Bonny Best, Stokesdale, Nystate, John Baer, Pritchard. Strains of Baltimore suitable in southern Oregon are too late in ripening further north. Rutgers is likewise too late. Valiant, a large firm-fruited variety, has not been satisfactory in color.

At the present time several hundred plant selections are being made as a part of a breeding program at Corvallis to develop a suitable variety.

Besides varietal problems, other factors of importance affect the production of tomatoes for processing. Late blight (Phytophthora sp.) caused much damage to the 1941 crop but in a season of average rainfall and humidity it is not likely to be serious. Virus diseases including tip-blight and spotted wilt have menaced southern Oregon tomato crops for several years.

At the Southern Oregon Experiment Station strains of Baltimore are being developed for resistance to tip-blight and for earlier maturity of fruit. Certain flower plants are now known to be hosts to these virus diseases according to McWhorter and Milbrath (16).

Tomato growers should refrain from the use of tobacco in any form while actually working with tomato plants as a special precaution against contamination of the plants by tobacco mosaic.

The western yellow blight or curly top of the tomato, spread by the beet leaf hopper, is destructive in certain areas, but in western Oregon is seldom very widespread or serious. (17)

In recent years the corn earworm has done extensive damage to tomato fruits. Before the fruit is half grown dusting with calcium arsenate dust (see Ext. Bulletin 551) may be used. Pyrethrum dust should be used in later applications.

Soil fertilization studies in tomato growing indicate the following practices to be desirable: (1) Plowing under a cover crop or barnyard manure as early as possible in the spring so that the organic matter may be rotted before plant setting; (2) using starter solutions (15) to stimulate plants to early growth and blossoming; (3) applying phosphoric acid fertilizers previous to plant setting; (4) making a successive application of a complete fertilizer at rates of 200-300 lbs. per acre after a few of the early clusters of fruit have set.

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