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Oregon Agricultural College
Experiment Station

Department of Horticulture

Vegetable Gardening in Oregon

By
A. G. B. BOUQUET

CORVALLIS, OREGON

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By

A. G. B. BOUQUET

INTRODUCTION

This bulletin is designed to be of practical use to the commercial vegetable grower as well as to the home gardener. It is recognized that vegetables are staple farm products in general demand throughout the year. The value of vegetables grown in the State exclusively for sale amounts annually to approximately $1,500,000. As necessary crops in the farm home garden, the value of these products exceeds $2,750,000 yearly. The growth of the vegetable industry has proceeded along these two lines. The Northwest is generally conceded to be going through a steady process of development which is bound to affect the possibilities for marketing vegetables. Many cities have doubled their population in the past ten years, while hundreds of new farms and farm homes have increased the extent and value of farm vegetable gardens.

The requests for information concerning vegetable crops received at the Oregon Agricultural College are numerous and varied. The recommendations offered in this publication are based on investigational data and general observations of crops in the field, greenhouse, and frame.

Besides the special discussions in paragraphs of certain vegetables, the reader's attention is called also to the summarized table of general cultural methods found in the latter part of this circular.

VEGETABLE PRODUCTION FOR LOCAL MARKET

Many of the rapidly growing cities of the State furnish a good outlet for a wide variety of vegetables. The grower has a choice between producing a number of different crops such as peas, green onions, early and late cabbage, lettuce, rhubarb, roots of all kinds, sweet corn, squash, pumpkin, cauliflower, sprouts, etc., or he may prefer to grow a few specialties such as asparagus, rhubarb, melons, celery, head lettuce, tomatoes, and so on.

In order to obtain first-class land at a cheaper price, a vegetable grower can now well afford to grow his crops further from his city market than was formerly considered advisable, because of the improved highways now available and the possibilities of marketing products rapidly with trucks.

It is recommended that in the production of a variety of crops the grower seek to have part of the farm of a warm sandy loam soil, suitable for production of early crops and those which grow best on such land (see Table IV); also to have, if possible, a piece of higher land which will be well drained and not overflowed by excessive fall rains and high river water. Such land would be used for crops maturing in the fall, winter, and early spring as celery, late cabbage, cauliflower, sprouts, kale, broccoli, late root crops, etc. (See Table IV.)

Irrigation is essential to any intensive farming of a small area to vegetables if continuous cropping is to be practiced. If the land itself

used for market garden crops is naturally fertile, the watering equipment will soon prove to be a profitable investment.

Observations of the character of many vegetables offered for sale in city markets show that growers could well afford to grade and pack their vegetables in a better manner than at the present time. In order for a local grower to build up a first-class trade, it is necessary that he properly segregate his products according to their market value and deal fairly and squarely with his connections.

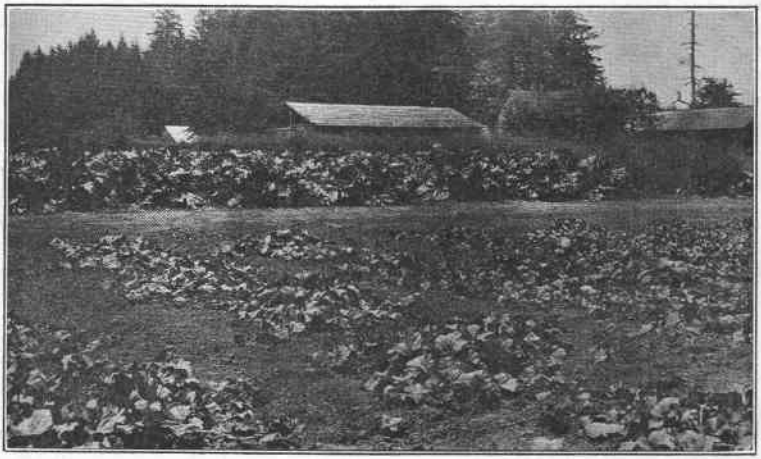

Fig. 1. General view of diversified vegetable farm, producing rhubarb, asparagus, melons, and sweet corn on sandy loam soil.

Many importations of vegetables into various city markets from other sections of Oregon and from other states are directly caused by the inability of the dealer to obtain locally a uniformly graded and packed product. This condition, which should not exist, can be remedied by greater attention on the part of the local grower to the demands of his market.

COMMUNITY PRODUCTION OF TRUCK CROPS

In the State, at the present time, several vegetables are being grown in sufficient quantities to be loaded and shipped in car lots. Examples of such community production are shown in the present industries of growing onions, broccoli, lettuce, cabbage, onion sets, and tomatoes. In the future it is to be expected that there will be an increase in the acreage of these crops and possibly also other vegetables.

In order that these vegetables may be extensively grown and shipped with profit to all concerned, certain definite things are necessary. First, there must be a sufficient acreage of any one crop to provide enough material for car-lot shipments; for instance, for broccoli and cabbage there should be about 40 acres, for lettuce 15 acres, tomatoes 40 acres, and so on.

Second, each grower should endeavor to sign up for only the acreage which he himself can properly tend. For example, in growing broccoli,

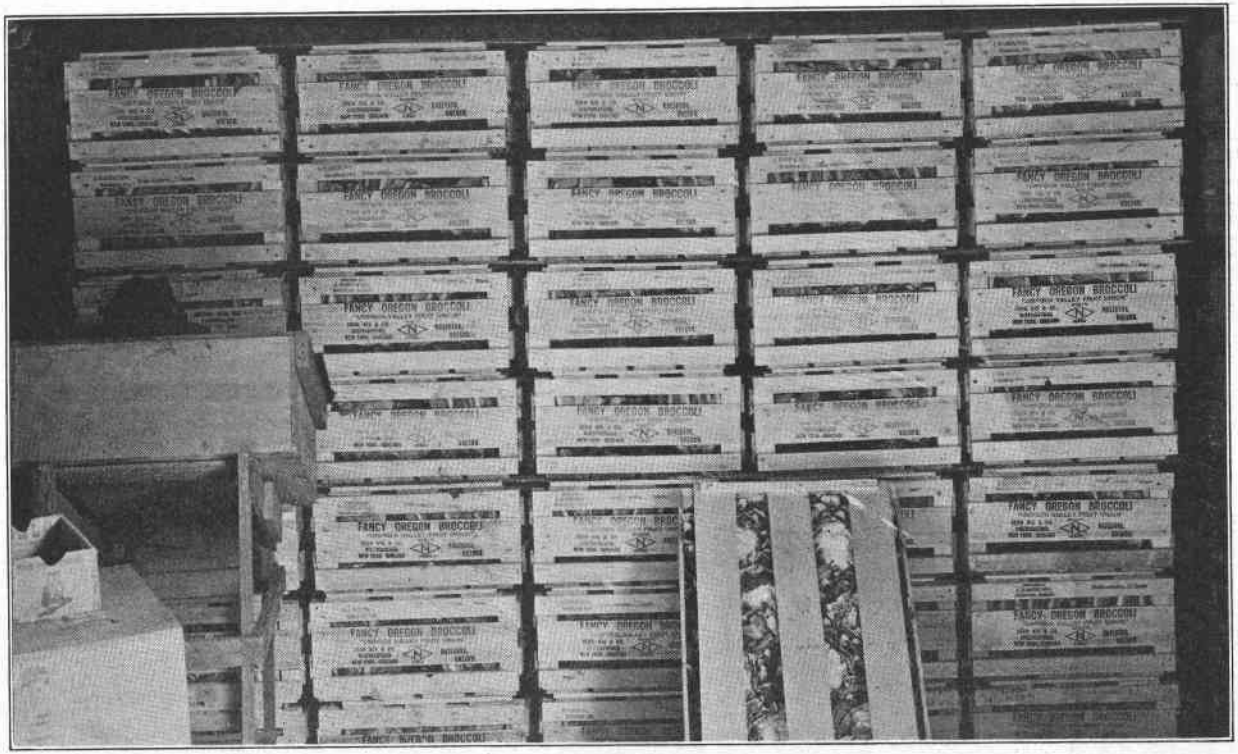

Fig. 2. Interior view of car of Oregon broccoli loaded for shipment. Si nce this photograph was taken, some modifications have been made with respect to the crate size and loading methods.

a grower's individual acreage will vary from 2 to 10 acres, the average grower farming 5 acres to this vegetable.

Third, the variety of vegetable should be planted generally, and if possible, the seed should come from one source so as to have uniformity in the strain. Variations in the character of broccoli loaded in cars have been largely due to the different sources from which seed has been derived to produce the crop.

Fourth, production methods, as far as possible, should be uniform so that each grower's crop will reach maturity at the same time, thereby making it easier to load cars.

Fifth, definite grade and packing rules should prevail to be used by each grower so that a uniform product may be loaded in the cars. Copies of United States standard grading rules for various vegetables may be obtained through the department of Horticulture, Oregon Agricultural College. As an example of grading rules see discussion of Broccoli.

VEGETABLES FOR CANNERIES AND DEHYDRATORS

Commercial establishments, located in different parts of the State, are desirous of obtaining at certain times of the year vegetables for canning such as string beans, beets, broccoli, cabbage, corn, cucumbers, pumpkin, rhubarb, squash, and in some cases tomatoes. Dehydrating plants, also, are in the market for various vegetables which dry well, such as string beans, carrots, celery, cabbage, onions, peas, spinach, squash, and some miscellaneous crops.

Under the climatic conditions which exist in the State, all of the above-mentioned vegetables attain a high quality, so that whether canned or dried, they are much sought after by wholesalers.

Contracts are offered to growers to produce these vegetables at a stipulated price per ton. Having a definite market price thus set upon the vegetable, it is necessary for the grower to produce as large as possible a tonnage to the acre in order to have large gross receipts. When the tonnage yield is small the overhead costs of production per ton are relatively greater. It is extremely important, therefore, that all factors concerned in the growing of these vegetables on contract be carefully considered, such as good land, high-grade seed, ample moisture for the crop's needs and so on. The cost of producing the crop should be known approximately so that the grower may estimate what tonnage it is necessary for him to obtain to pay production costs and leave a reasonable profit.

The largest yields of these vegetables are being obtained on rich sandy loam bottoms and soils of an organic nature such as the beaver dams and similar lands, chiefly because of the natural sub-irrigation of many of these soil types. Average yields of some of these vegetables are as follows: string beans, 3 to 4½ tons; beets, 3 to 6 tons; cabbage, 12 to 20 tons; carrots, 10 to 30 tons; rhubarb 10 to 12 tons; spinach, 3 to 6 tons; squash, 10 to 20 tons.

String beans where irrigated or growing on rich beaver-dam soils will continue to bear for a long period and give a high tonnage.

Beets are often grown as a first crop, followed by late cabbage or broccoli.

Broccoli for canning may be stock too large or too small for local marketing or for shipment. Nevertheless, it must be of good color and in good condition.

Carrot yields may be very large from soils of a peaty character, the roots reaching a large size without deteriorating in quality.

Celery strippings, as well as that which is unblanched, may be used for drying.

Spinach makes a good first crop and dries well. It yields particularly well on soils of a beaver-dam type. If grown on higher ground it may be followed by late cabbage, cauliflower, or broccoli.

Squash often makes a high tonnage when produced on the rich sandy loam soils, and yields of 20 tons to the acre are not uncommon.

Except in the southern part of the State tomatoes are not widely canned, the seasons in most areas not being warm enough to produce a sufficient tonnage to warrant growing the crop for the cannery.

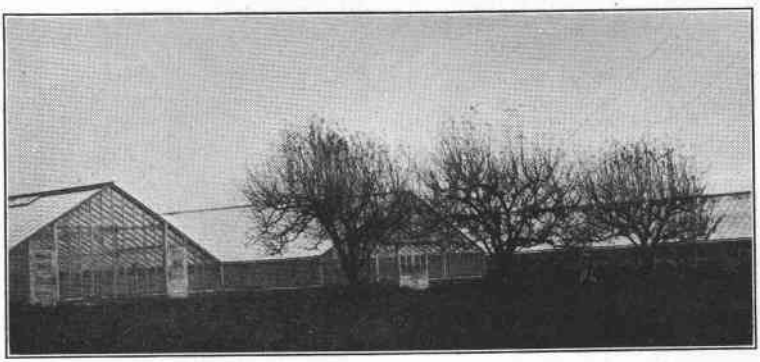

Fig. 3. View of part of the largest vegetable greenhouse range in the State. These houses are each 40 by 200 feet.

GREENHOUSE VEGETABLES

It has been found profitable by many gardeners to operate a range of greenhouses in connection with the growing of field vegetables. Some growers, in fact, testify that their greenhouse area is the most profitable of their entire acreage. There are in the State also those who operate vegetable greenhouses exclusively, without any relation to outdoor vegetable crops.

The production of vegetables under glass, besides helping to distribute the income of the grower throughout the year, also makes it easier for him to retain good help, which is usually scarce.

The most profitable vegetables grown in greenhouses are tomatoes and cucumbers. Other crops produced with less profit are lettuce, spinach, radishes, and rhubarb. A good yield of tomatoes should return to the grower two pounds of fruit, or 20 to 30 cents, to the square foot of area occupied by the crop. A well grown crop of cucumbers will usually return from 15 to 75 cents to the square foot of area, depending upon the intensiveness of growing the crop and the extent of training.

Tomatoes. The forcing of early tomatoes under glass is one of the most profitable means of operating a greenhouse range. The variety recommended is Bonny Best, using a special strain to obtain, if possible, high-yielding plants bearing smooth, well-colored fruit of excellent quality. Seed is usually sown early in January, the plants being later "pricked out" to a distance of two inches each way. When the plants are about five to six inches high, they are set out into five-inch pots to be thus grown for two and one-half to three weeks. They are set in the permanent beds when ten to twelve inches high, usually about March 15. Distances of planting vary considerably; probably the most common are 30 to 32 inches between rows and 14 to 18 inches between plants in the row. By pruning and training the plant is invariably modified to a

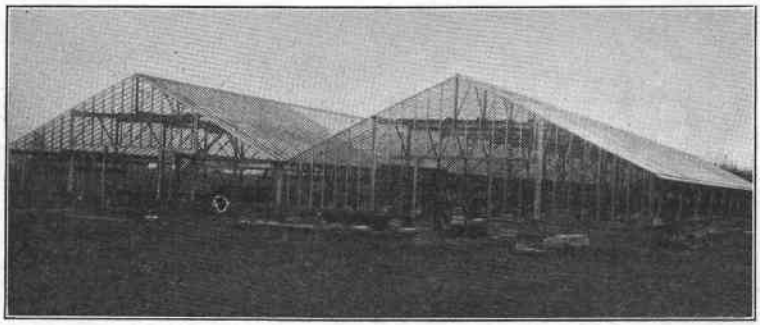

Fig. 4. New greenhouses, under construction, form additions to range shown in Fig. 3. These new houses are wide, steam heated, free from interior obstructions, and are economically operated.

single stem. Hand pollination is an important factor in growing the crop and essential to a high yield. Experiments in pollination carried on at the Oregon Agricultural College Experiment Station for a number of years indicate that the cost of hand pollinating is but very small compared with the beneficial results obtained. A summarized report of the means of pollination recommended and other data concerning the work can be obtained from the Oregon Agricultural College. The first ripe fruit is usually harvested about May 25, the season lasting till August 15. Prices range from 30 cents a pound at the beginning to 10 cents at the end of the harvesting period. Each plant should bear from 6 to 12 pounds of marketable fruit.

Two serious troubles, tomato mosaic and nematodes, are likely to be present in greenhouses producing tomatoes. Both are prevalent at the present time in greenhouses of the State, the mosaic disease in particular having already caused serious injury and considerable financial loss. The Oregon Agricultural College Experiment Station, through the departments of Plant Pathology and Entomology, is endeavoring to assist growers whose greenhouse soils are affected with these troubles. For further details, communications should be addressed to either of these departments of the Station.

Cucumbers. Cucumbers are grown in some greenhouses by starting the young plants in November, the first fruit in this case being harvested

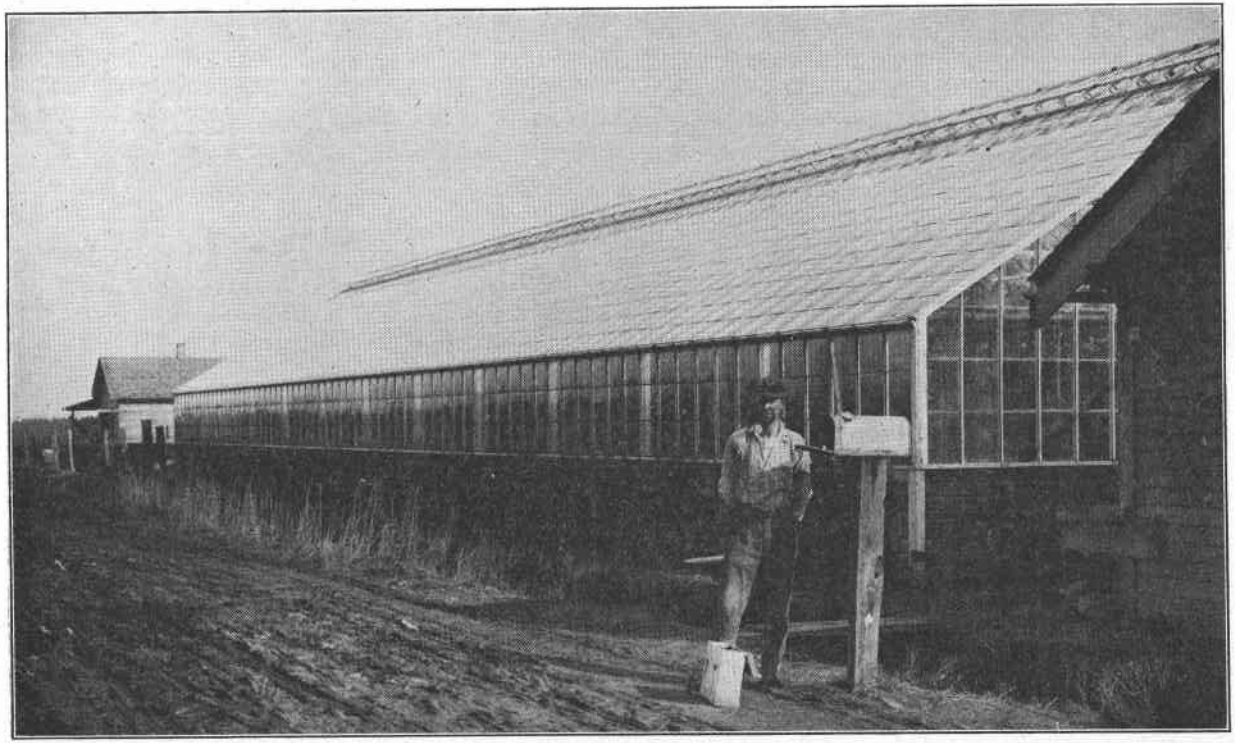

Fig. 5. Even-span greenhouse producing annually over 3000 dozen cucumbers.

in late February. Other crops are grown by sowing the seed in February or early March with a view of harvesting the first cucumbers during the early part of May. Again, some growers produce a crop which is harvested during October to January. The time of year when these crops are grown and harvested depends largely on the manner of operating the greenhouse throughout the year and the rotation of crops used. (See Third Horticultural and Crop Pest Report, pages 33-35.)

In growing greenhouse cucumbers there is no variety that is uniformly used, each grower having his own strain which he himself has selected. The tendency of all growers, however, is to produce a cucumber varying from 9 to 11 inches, straight, smooth, free from spines, and having an attractive dark-green color. Many of the strains now used first originated from the variety Davis Perfect. The distances of planting vary according to the method of training. One grower, who uses the erect method, sets plants 2 feet apart, the rows being two and one-half feet apart. The plants are trained to single stems, allowing each lateral to bear one fruit and "break" once for fruiting. This grower annually obtains a yield of 3000 to 3500 dozen from 1030 plants. Comparatively few serious troubles have yet been found affecting the growing of greenhouse cucumbers.

The operation of the greenhouse from September 1 to March 15 or 20 depends largely on the locality in which the plant is situated and upon the crops grown at other times of the year. Three crops of spinach may be produced or one crop of fall tomatoes or cucumbers followed by one crop of spinach. Leaf lettuce, as a general rule, is eliminated by reason of the regular shipments from California of head lettuce which has become so popular as to crowd out the loose leaf type. Thus far it has not been possible to produce in a greenhouse head lettuce that is solid enough and which is free from disease. For further details concerning a year's cropping, see the Third Horticultural and Crop Pest Report previously mentioned.

HORTICULTURAL VARIETIES OF VEGETABLES

From the many hundreds of varieties listed in seed catalogues, the vegetable grower must choose those which seem to him to be the most suitable, either by reason of his previous experience, or because of recommendations made to him. According to reports of growers, there is comparatively little difference in the varieties which are grown in the East, Middle West, and West. This is largely so because the majority of vegetable growers are united in choosing standard varieties of each vegetable which have proved their value through a number of seasons. For example, Earliana and Bonny Best tomatoes are grown in almost every northern area; so are Yellow Danvers onions, Chantenay carrots, Refugee beans, Davis Perfect cucumbers, Danish Ball Head cabbage, and so on. While new varieties are constantly being offered, there is a commendable tendency on the part of seed growers to work on established varieties with a view of continued improvement.

It has been manifestly impossible for this Station to test the many hundreds of so-called new varieties and introductions appearing from time to time. The investigational work with varieties has been largely along the lines of comparing strains of seed of standard varieties, realizing that the variety itself is no better than the strain of it which is being

used. Too often a vegetable grower condemns one variety or another as being unprofitable without considering the seed strain.

The following recommendations as regards suitable varieties of vegetables for the Northwest are based on trials conducted in the Station grounds and elsewhere, and also on the results which growers have obtained in using these varieties for the commercial production of vegetables, as well as a consideration of the requirements of "the trade" representing popular demand.

In every case a variety has been chosen because of some especially valuable characters or qualities which it possesses, earliness, fine quality, productiveness, attractiveness, suitable market color, size or shape, and so on. For example, in order to make it possible to grow field tomatoes with the greatest profit, it is absolutely necessary that a grower choose an early ripening variety as well as one that is good enough looking to make an article that will sell at a rather high price. A good strain of Earliana is recommended. Later in the season, a more attractive tomato may be marketed, such as Bonny Best. Earliness is an essential character in growing sweet corn, hence the selection of the first-named varieties. Solidity is a necessary feature of any head lettuce to be sold readily. Our recommendation is, therefore, the exclusive use of a good strain of New York.

VARIETIES RECOMMENDED

Vegetable	Variety
Asparagus	Reading Giant, Palmetto, Washington.
Beans, snap	Green: Refugee, Stringless Green Pod, Dickenson's Yount, Kentucky Wonder.
	Wax: Davis, Black Wax.
	Lima: Oregon Lima.
Beets	Early Model, Detroit Dark Red.
Broccoli	St. Valentine, Late Queen.
Brussels sprouts	Danish Prize.
Cabbage	Jersey Wakefield, Copenhagen Market, Glory, Danish Ball Head.
Carrot	Chantenay.
Cauliflower	Dry Weather, Gilt Edge, Easy Blanching.
Celery	Golden Self Blanching, White Plume.
Chard, Swiss	Lucullus.
Chicory	Witloof.
Chinese cabbage	Wong Bok, Pe-Tsai.
Corn, sweet	Portland Market, Golden Bantam, Howling Mob.
Cucumber	Davis Perfect, Boston Pickling.
Eggplant	Black Beauty.
Kale	Dwarf or Tall Green Curled Scotch.
Kohl-rabi	White or Purple Vienna.
Lettuce, head	New York, Iceberg.
Mustard	Fordhook Fancy.
Muskmelon	Emerald Gem.
Onion (seed)	Oregon Yellow Danvers, Australian Brown.
Onion (sets)	Yellow Strasberg, White Portugal, Australian Brown.
Parsley	Dwarf Moss Curled.
Parsnip	Tender Heart, Hollow Crown.
Peas	Laxtonian, Early Morn, Alaska, Little Marvel.
Peppers	Chinese Giant, Pimento, Red Chili, Cayenne.
Pumpkin	Winter Luxury.
Radish	Scarlet Globe, Scarlet Turnip white-tipped, Icicle.
Rhubarb	Mammoth Red, Riverside Giant.
Salsify	Mammoth Sandwich Island.
Spinach	Victoria, Long-standing.
Squash (summer)	Crookneck, Vegetable Marrow.
(fall)	Boston Marrow, Delicious.
(winter)	Hubbard, Banana.
Tomato	Earliana, Bonny Best, John Baer, Perfection.
Turnip	White Egg, Purple Top Milan.
Watermelon	Kleckley Sweets, Hungarian Honey.

SEEDS AND SEED STRAINS

It is of prime importance that the vegetable grower realize the benefits which are to be obtained by him in the use of high-grade seed strains which preferably are acclimated or grown in the Northwest. By high-grade strains are meant those which produce vegetable crops that show a uniform strain or type of high market quality throughout the field. Vegetable growers should bear in mind that the highest qualities in a vegetable can be developed only by careful and persistent breeding with a view of eventually having pedigreed strains that produce vegetables true to the desired type. Progress has taken place in other lines of agriculture through the use of productive strains, such as in high egg-laying hens, heavily producing cows, unusually superior yields of grain, and so forth. In a similar manner, better vegetable seed strains are

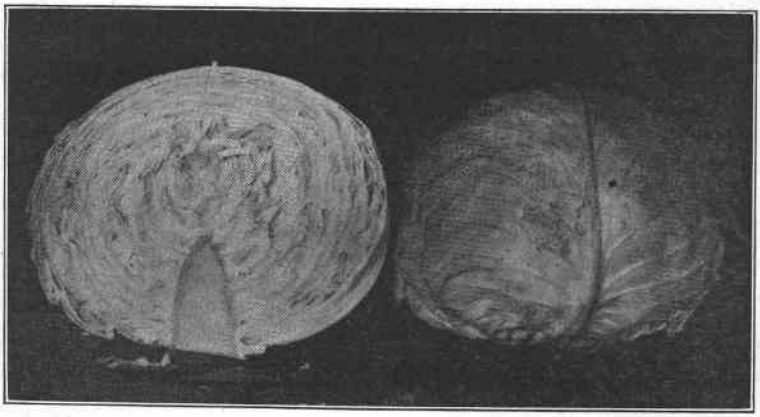

Fig. 6. Improved type or strain of late cabbage. Note small-sized core, and tightly folding character of head leaves, indicating solidity.

capable of producing vegetable crops of greater value. The work of perfecting these, however, entails added time and labor, thus causing a higher price to be asked for such stock. Growers of vegetables should appreciate this fact and should be willing to pay more money for seed of selected strains.

The influence of inferior seed strains is seen in many Oregon gardens. In squash crops, large seed cavities and thin flesh of poorly shaped squash are common; in cabbage crops, large cores and light weight of heads which are by no means "tight;" in onions, poor uniformity of color and shape, as well as lacking keeping qualities; in tomatoes, rough fruits, ill-shaped, and late in ripening; in beets, distinct and undesirable light interior zones or rings; in cauliflower and broccoli heads, various colors other than white and textures which are "leafy" and "ricey."

On the other hand, we find in superior strains of these same varieties, just the opposite conditions to those mentioned; namely, in squash, greatly reduced seed cavities and a large percentage of flesh; remarkably tight cabbage with small cores; onions which are extremely solid, uniform in all characters, and keeping a long time; tomatoes which are smooth, uniform in size, and bearing an abundance of early fruit; beets

with almost a total absence of light zones; cauliflower heads of good uniformity and perfect "curds" in texture; and many other examples.

In the Third Horticultural and Crop Pest Report of the Oregon Agricultural College Experiment Station, a summarized report is given in tabular form showing the findings of a strain test of broccoli seed, each crop being grown from a different strain of the same variety, St. Valentine. This table is reproduced here as an example of the discussion in the foregoing paragraphs.

TABLE I. COMPARATIVE VALUES OF BROCCOLI STRAINS

Strain No.	Marketable heads	Small heads	No head	Cabbage cross	Cabbage cross marketable heads	Off type	Kale cross	Remarks
%	%	%	%	%	%	%	%	
1	33.6	24.2	32.6	.....	....	9.1	...	Strain lacked vigor and uniformity. Large number producing no heads.
2	80.6	9.2	3.3	.....	....	3.7	2.3	A superior strain showing good uniformity and little deterioration.
3	80.0	18.7	.....	.....	....	1.7	....	Very similar to No. 2.
4	77.2	21.2	.....	.....	....	1.5	....	Typical of some home-selected strains.
5	40.0	31.4	.....	20.0	5.7	2.8	....	Bad cabbage-crossed strains
6	57.3	16.5	.....	10.9	1.8	6.1	6.4	of little value.

Again, it is to be noted that the stability of the industry and high market quality of Oregon onions are largely due to the seed strains of Yellow Danvers, which growers themselves have bred for fifty years or more, saving annually those bulbs which show greatest tendency toward solidity through a long period of storage as well as having other desirable market qualities.

Furthermore, strain tests of late cabbage conducted at Corvallis and elsewhere show that there are two or three strains which far out-yield and rank higher in general value than the average strain of Danish Ball Head. One of these strains has produced a crop averaging less than 5 percent cull heads.

Similar results with strains of other vegetables have been experienced on the Station grounds, lack of space preventing the publication of the data in the present circular.

Acclimation of Seed. It is to the best interests of the gardener to plant not only northern-grown seeds as far as possible, but also to use acclimated strains, especially of peas, cabbage, beans, sweet corn, squash, pumpkin. Acclimated strains of sweet corn will produce from 50 to 100 percent larger crops than other strains of the same varieties. There is an added vitality and vigor to vegetables from State-grown seed, consistent, of course, with proper selection as to type and general characters of value.

GROWING YOUNG VEGETABLE PLANTS

A necessary part of the equipment of a garden, whether a commercial enterprise or a home garden, is a certain amount of glass, either in the form of a greenhouse or hotbed sash. For the commercial grower

who is producing vegetable plants for himself to be set out later in the field a small propagating greenhouse is of great value. As a rule a more uniform and better quality lot of seedlings of early cabbage, lettuce, cauliflower, tomatoes, peppers, eggplants, and celery can be grown in this plant house than in hotbeds. The plants are handled, too, with greater ease and there is less danger of their failing to make a satisfactory growth. As a matter of fact, one can grow an excellent lot of seedlings in a plant house, and many growers, realizing this, are displacing their hotbeds with the greenhouse. Manure for heating a hotbed, also, is scarce. Some glass sashes in the form of cold-frames are a necessity in hardening greenhouse-grown plants, so that a sufficient number of sash must be provided to take care of the plants before they are set in the field.

Plans and specifications for a small plant house are stated under separate cover (Oregon Agricultural College mimeograph circular 184), in which details are given showing that a greenhouse 20 feet by 30 feet can be erected for approximately $250.00 in actual cost of materials, exclusive of cost of heating equipment, which should be inexpensive.

Immediately after the season of growing seedlings, the house can be set to tomato plants, which will begin to bear ripe fruit in July and will produce a total yield of 500 to 600 pounds, at prices varying from 20 to 5 cents a pound. During the winter months the house can be used for lettuce, spinach, radishes, or all of these crops.

Investigational work in such a house at Corvallis shows that 25,000 to 30,000 or more miscellaneous seedlings can be grown from February to May 31.

The gross receipts for the year will pay for the first cost of the greenhouse and leave a balance of profit.

The following table sets forth in detail the manner of growing young plants of various vegetables. Distances at which these are "pricked out" depend largely on the individual grower; those mentioned in the tables are based on our experience in growing a good vigorous plant. Dates of seeding are dependent also on the locality in the State.

TABLE II. SPRING-GROWN VEGETABLE SEEDLINGS PLANTING TABLE

Vegetable	Variety	Dates seeding	Dates "pricking out"	Distance "pricking out"	Date field setting	Height plants	Field planting		Maturity
							Rows	Plants	
				in.		in.	in.	in.	
Early cabbage	Early Jersey Wakefield Copenhagen Market	Feb. 10-March 1	After 12-16 days	1½-2	March 25-April 20	6-8	28-30	16-18	July 1-Aug. 15
Head lettuce	New York	Feb. 10-March 1	After 12-16 days	1½-2	March 25-April 20	3 pairs of leaves	12-18	10-12	May 25-June 20
Onions	Oregon Yellow Danvers	Feb. 1			April 10-25	6	14-18	3	Aug. 25-Sept. 15
Cauliflower	Snowball	Mar. 1-15	After 12-14 days	2	After frost	6-8	36	26-30	July 10
Celery	Golden Self-blanching	Mar. 10-April 1	After 6 weeks	2-2½	June 20-July 25	6	28-32	6-8	Sept. 20-Oct. 25
Tomatoes	Earliana Bonny Best John Baer	March 1-April 10	After 3-4 weeks	4	After frost. May 15-June 10	8-12	48-60	36-54	July 25-frost
Peppers	Chinese Giant Pimento	Mar. 1-10	After 4 weeks	3-4	June 10-20	6-10	24-30	15-20	Aug. 1-frost
Eggplants	Black Beauty	Mar. 1-10	After 4 weeks	4 or in pots	June 10-20	6-10	24-30	18-24	Aug. 20-frost

Explanation.

1. Onions are transplanted into the field directly from seed bed in box in greenhouse or hotbed.
2. Cauliflower plants, while growing as rapidly as cabbage, are susceptible to checks and produce "button heads." Later seeding is therefore desirable.
3. Dates of work vary according to conditions existing in various parts of State.
4. Tomatoes, eggplants, and peppers can first be "pricked out" to two inches and later be transplanted to four inches as indicated in table.
5. Seedlings which are greenhouse grown can be conveniently handled in flats or plant boxes.
6. Plants grown in manure-heated hotbeds should be started no later than the first date in each case. See Oregon Agricultural College mimeograph circular 135 on hotbed construction and management.

PROFITABLE USE OF FRAMES

Cold-frames are primarily intended for use in hardening vegetable plants before they are set in the garden. The period during which they are used for this purpose begins late in March with cabbage, lettuce, and onion plants, and ends in June with eggplant, pepper, and celery plants. During April and May, therefore, the frames are hardening plants such as the first mentioned and also cauliflower and tomatoes. In most cases the hardening period begins about 10 to 16 days before the date of setting in the field. (See Table II.)

During the summer and fall the frames should be producing crops so as to help reduce the overhead charges in cost of maintenance in the spring. If possible, vegetables such as lettuce and cucumbers should be

grown so as to permit of their being harvested by early September, for at that time the frames should be planted to lettuce plants for a crop maturing through October and November. This will assure the use of the frames as long as possible during the year.

In growing fall lettuce, best results have been obtained in using a solid heading strain of "New York" or "Wonderful," setting the plants 10 inches by 10 inches during September. Glass should cover the plants during cold nights. A four-sash frame, 6 feet by 12 feet will produce fall lettuce valued at $5.00 to $7.00.

SOIL TREATMENT FOR DISEASES

Vegetable growers, especially those who are operating greenhouses and frames, are likely to experience a great deal of difficulty due to fungi which are carried in the soil and which cause large losses on account of the attacks which they make on delicate seedlings or even on further-developed plants. In the Station vegetable greenhouses, considerable trouble has been caused by the "damping off" fungus, affecting young plants of cabbage, cauliflower, lettuce, tomatoes, spinach, and others. This fungus is likely to cause the greatest amount of general injury in plant growing.

Small areas of soil can be conveniently sterilized by using either boiling water or formaldehyde.

The Boiling-Water Treatment. This method has recently been introduced in the eastern United States, where it is being used with great success by some of the greenhouse gardeners on a large scale. There is no reason why it should not be equally effective when used on a small scale for seed beds, cold-frames, flats, and so forth. The principles involved in the use of this method are simple:

First, the soil should be thoroughly dry in the beginning so that it will take up the greatest possible amount of hot water.

Second, before treatment, the soil should be thoroughly loosened up, to insure an open, porous condition, so as to permit rapid penetration of the hot water.

Third, the water, sufficient to saturate all the soil to be treated at one time, is heated in any kind of boiler or kettle until it is actively boiling. For treatment in larger greenhouses, a special arrangement is necessary, on account of the large amount of earth to be sterilized. Details of the methods employed in such cases may be secured by writing to the plant pathologist of the Oregon Agricultural College Experiment Station.

Fourth, the boiling hot water is applied quickly to the soil in such a manner as to secure a rapid and uniform penetration through the entire depth of the soil, thus raising the temperature of that soil almost immediately to the point destructive to the life of the parasitic fungi contained in it.

Fifth, shallow beds or flats should be covered immediately with blankets to retain the heat as long as possible. Flats may be piled one on top of another, and the entire pile covered over. Care should be taken to prevent a rapid lowering of the temperature through any cause, since the heat employed should be retained for some time in order to have maximum effectiveness.

After twenty-four hours the beds may be uncovered and allowed to cool off and to dry out. When sufficiently dry, the seeds may be planted in the usual manner.

Formaldehyde Treatment. Due to the fact that the Station greenhouses are heated with hot water, it has been found necessary to sterilize the beds and benches at least once a year with formalin, using as a soil drench 2 pints of 40-percent formalin to 50 gallons of water, applied at the rate of three-fourths of a gallon to one gallon of the diluted mixture per cubic foot. This treatment is effective in controlling soil diseases but has its limitations in so far as nematodes (eel-worms) are concerned.

Miscellaneous Diseases. The following diseases affecting particularly greenhouse crops have appeared at various times in the Station greenhouses, and in commercial plants of the State: tomato leaf spot, tomato mosaic, botrytis of lettuce, cucumber mildew. Methods of controlling these individually are not included in this circular, but the grower should address the department of Plant Pathology, Oregon Agricultural College Experiment Station, for information.

TABLE III. SUMMER-GROWN VEGETABLE SEEDLINGS, PLANTING TABLE

Vegetable	Variety	Date seeding	Distances seeding	Date field setting	Distances field setting		Maturity
					Rows	Pl'ts	
			in.		in.	in.	
Late cabbage	Glory Ball Head	Apr. 20-May 10	½ x 18	June 15-July 20	36-42	28-36	Sept.-Dec.
Cauliflower	Gilt Edge Dry Weather	May 1-June 10	½ x 18	June 20-July 30	36-42	30-36	Sept.-Nov.
Broccoli	St. Valentine	April 25-May 10	½ x 18	June 20-July 15	36-42	30-36	Feb. 20-Apr. 25
Brussels sprouts	Danish Prize	May 1	½ x 18	June 20-July 15	36	30-32	Oct.-Dec.
Scotch kale	Tall or Dwarf Scotch curled	May 1	½ x 18	June 20-July 15	36	24-30	Oct.-Feb.
Ch. cabbage	Wong Bok	July 15-Aug. 1	1 x 18	Sept. 10-20	24	10-12	Oct.-Nov.

Explanation. There is but one transplanting of the above-mentioned plants; viz., from seed bed to the field.

SOILS FOR VEGETABLES

Experiments in growing vegetables on many different types of Oregon soils demonstrate the wisdom of choosing an unusually good piece of ground for vegetable production. It must be superior, particularly from the physical standpoint, having in mind the importance of good drainage, easiness of being pulverized, high content of organic matter, unusual moisture-holding capacity or adaptability to being irrigated. The necessity for good drainage is particularly emphasized in growing late crops such as broccoli, curly kale, Brussels sprouts, spinach, celery, late cabbage, late head lettuce, root crops, etc.

Fig. 7. Harvesting asparagus from field of twenty-five acres devoted to this vegetable. The soil of this area is a rich sandy loam, capable of producing an early and large yield of asparagus.

Trials conducted in growing onions on various soil types have shown that greater yield and fine quality are to be obtained by growing this crop on muck land. Again, it has been shown by conclusive tests that for commercial crops of tomatoes, eggplant, peppers, muskmelons, asparagus, and rhubarb, sandy loams with a high soil temperature give earliest and heaviest yields.

The following table presents the data in concise summarized form:

TABLE IV. RELATION OF SOIL TYPES TO VEGETABLES

Vegetable	Soil	Remarks
Asparagus Rhubarb	Sandy loam to silt loam	Looseness and warmth increase early production and give higher yield.
Cantaloups Cucumbers Watermelons	Sandy loam to silt loam	Early maturity hastened by warm soil and rapid growth of plants.
Tomatoes Beans Eggplants Peppers	Sandy loam to silt loam	Fruit ripens several weeks earlier. Early and continuous production if irrigated. Warm soil necessary for good yield. Warm soil necessary for good yield.
Onions	Muck and peat (Beaver dam)	Highest yields from rich, moist, but well-drained lands. Some good yields also from silt loams.
Celery	Beaver dam Sandy loam to silt loam	Variety of soils producing celery, with best crops on rich loams, or tile-drained.
Cabbage	Silt loam Clay loams	Rich loams capable of holding moisture necessary. Drainage essential for late harvesting.
Cauliflower	See cabbage	Requires unusually well fertilized land of moisture-holding capacity.
Broccoli	See cabbage	Drainage of prime importance—low water table in winter. Good rich loam preferred.
Head lettuce	Sandy loam Beaver dam	Preferred soils are those either irrigable or holding moisture well. Rich "bottom" or sandy loams valuable.

FERTILIZERS

Stable manures are considerably scarcer at the present time than formerly, with the result that the vegetable grower who has heretofore used a large amount of manure has been forced to modify previous methods of fertilizing his garden. Cover crops and commercial fertilizers have therefore become more largely used. Frequent requests are received by the department of Horticulture as to the best manner of fertilizing a certain piece of ground for various vegetables or a certain vegetable. Often accompanying this request is a sample of soil sent for analysis. It is usually unnecessary to make this single analysis, inasmuch as the sample is probably one which is fairly representative of a certain type of soil already analyzed and concerning which records are on file at the Experiment Station.

It has been definitely shown by trials with fertilizing materials on various farms that each garden represents an individual problem. Thus recommendations which might be made for one area might not necessarily be applicable to another garden.

The summary of field trials with fertilizers on onion lands treated at some length on later pages shows that different fields to which the same fertilizers were applied gave a wide variation in yield. On broccoli fields, also, applications of commercial fertilizers have shown positive net increases in yield in some instances, where on adjacent fields, which were planted at the same time, no increases have been obtained.

The vegetable grower should consider that there are many factors affecting the efficiency or usefulness of commercial fertilizers. Where irrigation is available there is a greater possibility of using them with profit. Where no irrigation can be carried on, applications of fertilizers are likely to affect plant growth but slightly, unless they are made early enough in the spring to be affected by the spring rains. If the soil humus has been well maintained and the land is reasonably mellow there is every reason to believe that applications of standard fertilizing materials, made at the right time, will be attended by a crop increase. Whether this increase will be large enough to pay for the cost of the fertilizer and leave a profit is an individual farm problem. Soils which are hard and refuse to break up into a mellow condition will very likely not give any

Fig. 8. Fertilizer tests on beaver-dam onion lands. Each plot of equal size but receiving different fertilizer treatment. The harvest tells the story in the number of onion sacks per plot.

noticeable increase in applications of fertilizers, except stable manure and cover crops, which should, therefore, be the first consideration. Other factors that tend to nullify the usefulness or value of fertilizing materials are a poor stand of plants in the field due to improper seeding, and careless transplanting; while insects which might eliminate many plants would easily reduce the yield so as to make the expenditure for fertilizer an unprofitable one.

Mimeograph circular 162, of the Oregon Agricultural College Extension Service, also dealing with fertilizing materials for vegetable crops, is available for gardeners.

On a basis of field practices it is recommended that for closely growing vegetables such as lettuce, spinach, onions, cabbage, cauliflower, peas, beans, etc., an application of complete fertilizer can be made to the extent of 600 to 800 pounds an acre, this application to be made in the spring during the final preparation of the soil, and lightly disked or harrowed into the top surface of the soil. Such a fertilizer might have an analysis or guarantee of 3-8-3 or 2-10-2. Vegetables of considerable value which are likely to be influenced by applications of commercial fertilizers are such crops as celery, tomatoes, lettuce, cauliflower, broccoli, asparagus, cantaloups, onions, etc.

Growers who are in the habit of using commercial fertilizers to any extent are urged to make a few simple tests of fertilizers on their own gardens with certain vegetables which they are growing as specialties in order that they may obtain definite records as to the value of various fertilizing materials in their effect on the yield of the crops.

Fertilization for individual crops is considered more fully under the discussion of the various mimeograph circulars of individual vegetables, as mentioned later in this publication.

Cover Crops. Where the removal of crops permits seeding in the fall it will in many cases be found advisable to sow a cover crop, consisting of 30 pounds of vetch mixed with 20 pounds of oats or rye to the acre, sown in drilled rows as early as possible in the fall. Sometimes it may be possible to make a sowing of this seed between rows of plants that have not yet been harvested.

Manure. In view of the scarcity of manure it is important that it be used with the greatest care to obtain the most value from it and to apply it at such a time and manner as to use it with the greatest economy. Recent experiments have shown that it is possible to decrease the amount of manure formerly applied and yet obtain satisfactory yields of vegetables by adding to the soil some high-grade complete commercial fertilizer. Applications of well-rotted horse manure to the extent of ten tons and of six hundred to eight hundred pounds of high-grade fertilizer have in many cases given satisfactory yields. The greatest value is obtained from manure when it is well rotted, evenly distributed over the soil, applied preferably during the spring at the time of soil preparation. The manure should not be turned under the ground deeply, preferably being thoroughly disked into the soil. Where coarse, strawy manure is used it may have to be plowed under in order properly to mix it with the soil.

IRRIGATION

Need of Water for Vegetables. Vegetables contain a high percentage of water and in order that profitable yields may be obtained, as well as a high degree of quality, there must be an ample supply of moisture available, either naturally, because the soil holds moisture well, or artificially, because some provision is made for irrigation.

In certain parts of the State, notably the arid and semi-arid sections, irrigation is necessary in the growing of vegetable crops. In the

western portion of Oregon, irrigation is a valuable supplement to the rainfall, most of which is distributed over certain definite periods of the year, usually from October to June, leaving the summer season dry and unfavorable to intensive vegetable growing. In fact, whether an area of ground can be intensively farmed to vegetables or not is largely a question of availability of water for irrigation purposes. It is particularly desirable, therefore, for a vegetable grower to have facilities for watering his land, not only that he may be able to grow more than one crop a year on the same soil, but also for the purpose of insuring a sufficient supply of water for the needs of a single crop. Some vegetables, such as celery and fall head lettuce, must be irrigated even in sections where irrigation is not commonly practiced.

The value of irrigation water lies largely in its availability during the best growing seasons of the year and in its helping to make available fertilizers which may have been applied to the soil.

The majority of gardeners are situated near supplies of water so that in most cases irrigation is merely a question of installing proper equipment. In the future of gardening in the State, it is estimated that there will be a large increase in the acreage of vegetable crops which will be grown under irrigation, not only in those areas where watering is a necessity, but also in the so-called non-irrigated districts.

Sources of Water. For small acreages where the subsoil is composed of layers of sand and gravel, driven or dug wells are cheap and effective in producing an abundance of water. An ample supply is being obtained in the Experiment Station gardens from wells 15 to 18 feet deep. The pipe for a driven well should not be less than four inches in diameter. Other growers whose acreage is located near a running stream, make use of this as a source of water. Many gardeners are already irrigating their vegetables by using the water from such rivers as the Rogue, Umpqua, McKenzie, Willamette, Clackamas, Santiam, and Columbia.

In some cases, drainage water is also used, as discussed in other paragraphs.

Power and Equipment for Pumping. While various types of pumps are used, centrifugal pumps are employed most largely in obtaining the water from many of the sources mentioned above. Whether the power is furnished by electricity or gas is dependent upon the nearness of the farm to an electric line. One prominent vegetable grower uses as his source of water supply an eighteen-foot dug well four feet in diameter, extending well below the water plane. The power is furnished by a gasoline engine working a 7-horse-power centrifugal pump. Distillate is used for fuel. The total vertical lift is about 22 feet. The water is discharged into a 6-inch pipe leading into a concrete tank, from which the water is led through concrete tile to the highest parts of the farm, from which it is later distributed by gravity. General varieties of vegetables are grown and irrigated on this farm.

Another grower specializing in celery and peppers derives his water from an adjacent river, using electricity for power, the pump being a Myers No. 502, horizontal reciprocating, drawing water 20 feet and discharging it into a 1½-inch pipe. Home-made portable sprinklers distribute the water. It is estimated that 25,000 gallons of water are applied for each irrigation.

One of the largest installations of irrigating equipment, recently made, included an electrically driven, directly connected centrifugal pump of standard design, drawing water from the river 16 feet, the delivery being at the rate of 400 gallons a minute. The distribution in this case was by means of Skinner overhead pipes watering a variety of vegetables.

In some cases, the pumping outfit consists of an Evinrude unit centrifugal pump with motor attached, which can be used as a portable pump to obtain water from any adjacent lake, pond, or drainage ditch. Several of these are now being used in irrigating intensive areas of land farmed to vegetables. Again, other small areas are being watered with a hydraulic ram as a means of forcing the water to the desired points of distribution.

Distribution by Gravity. Where the water is applied to garden crops by gravity, it is necessary that the ground be leveled to an even slope before watering. Many gardeners are successfully irrigating their acreage by distributing the water to a main ditch from which lead several laterals opened lengthwise of the rows.

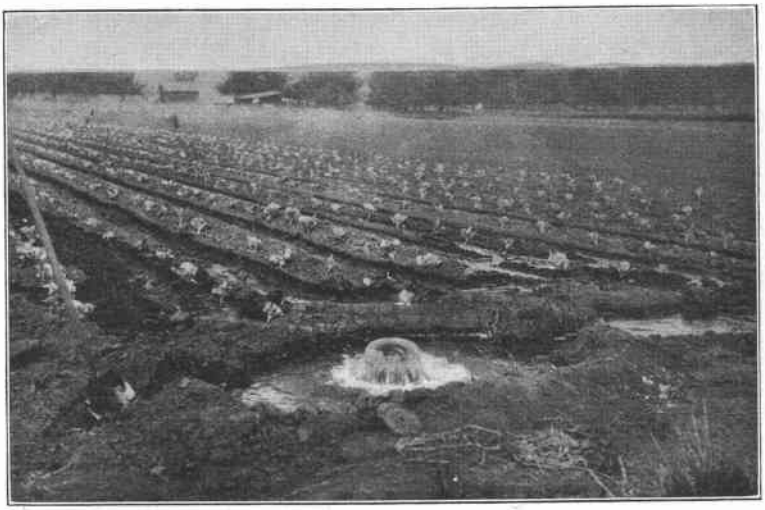

Fig. 9. Late cabbage plants being irrigated by gravity system, after being transplanted as a second crop. The water rising in the foreground, is coming out of the end of concrete tile leading to the discharge pipe of the pump.

Vegetables which are best irrigated by running the water in furrows along by the side of the plants are: tomatoes, sweet corn, rhubarb, cucumbers, melons, beans, squash, and in general crops which are grown with a rather wide distance between the rows.

Distribution by Sprinkling. In instances where the overhead system of sprinkling is used, the method is to install either permanent overhead pipes set on posts, or to have portable sprinklers which can be used on various parts of the land when attached to pipes carrying water. If the overhead pipes are placed permanently, the pipes should be one to one and one-fourth inches in diameter, having nozzles drilled 3 to 4 feet

Fig. 10. Part view of installation of sprinkling system on twenty acres. Crop in view is early cabbage to be followed later by late celery.

apart. The lines of pipe are usually 50 feet apart, supported on posts varying from 4 to 7 feet in height, and are rotated in such a way as to draw a stream of water about 25 feet on either side. (See illustration.) In case these sprinkling systems are used, there should be a pressure of at least 25 pounds to the square inch for a mist spray to be thrown.

Vegetables which can be suitably irrigated by this method are particularly those which are intensively grown with the rows comparatively close together, such as lettuce, spinach, bunch carrots and beets, peppers, celery, early cabbage, etc.

Fig. 11. Portable sprinkling outfit, home-made, being used for irrigating celery. The sprinkling device is attached to pipe extended over the entire area.

While this overhead method of irrigation usually entails a greater first cost of installation, it is more cheaply operated than other methods. It is particularly valuable for sandy soils which can receive light, frequent irrigations.

Some growers at the present time have installed this method of irrigation for the purpose of growing their broccoli plants in the seed bed, feeling more assured that they will obtain high germination of seed and a steady growth of the plants for transplanting later to the field.

Distribution by Sub-irrigation. Some trucking lands are being successfully irrigated at the present time by the adoption of some method of sub-irrigation. Soils which are low lying, such as the beaver-dam soils, muck lands, tule lands, and some sandy loams, can often be successfully sub-irrigated. Onion lands of the beaver-dam type are irrigated in this way by allowing the water to be backed up in the drainage ditches, from which it is forced into the drainage tile.

One prominent celery grower irrigates his land by providing open ditches four rods apart in which the water is allowed to flow, being kept at a height suitable for the crop. This is an ideal method of watering this vegetable.

Double Cropping by Means of Irrigation. Growers who have means of watering their land are enabled to grow at least two crops on the same soil during the season, using such first crops as beets, peas, spinach, green onions, radishes, spring lettuce, early cabbage, and following these with late beans, late sweet corn, fall lettuce, late carrots, late beets, eggplant, peppers, fall spinach, celery, etc. The water is especially valuable after the removal of the first crop, either in serving as a means for rapid germination of seed, or in providing a moist soil for easy transplanting of young plants.

Vegetables Usually Grown Without Irrigation. In the non-irrigated sections of the State, it is customary to find excellent crops of the following vegetables being grown without irrigation; namely, late cabbage, broccoli, cauliflower, brussels sprouts, onions, squash, pumpkins, tomatoes, sweet corn, and root crops. In most cases, these crops are grown on types of soil which either hold moisture well enough to supply the needs of the crop, or in some instances, the land may be naturally sub-irrigated, as in the case of the so-called muck lands.

INSECT PESTS AND THEIR CONTROL

Practically all vegetable gardens are injured to a greater or less extent each year by insects. While the fruit grower of the Northwest has applied himself diligently to the control of orchard pests, the average gardener has not yet made a definite, clear-cut practice of fighting vegetable insects. In order that profitable vegetable crops may be grown, it is absolutely necessary that the grower consider the control of insects an essential part of the routine work of production.

In growing vegetables on the Station grounds, the following insects have been found especially prevalent and doing extensive damage: the garden slug, cutworms, aphids, root maggots, and grasshoppers attacking a variety of crops; also particularly the following individual insects: cabbageworms, twelve spotted cucumber beetle, tomato flea-beetle, striped cucumber beetle, corn ear-worm, pea and bean weevil.

The methods which have been used in dealing with these insects are plainly set forth in Oregon Agricultural College Extension Bulletin 325, by A. L. Lovett, and the gardener is referred to this publication for suggestions as to insect control.

LATE CABBAGE

In the growing of this staple crop, which is produced to the extent of 500 cars annually in the State, yields and market qualities are very largely influenced by the following factors: First, the seed strain; second, the ability of the land to hold moisture through the dry period of the summer; third, fertility of the soil; and fourth, efficiency in counteracting the work of injurious insects.

Seed Strains. This Station has made frequent tests concerning the relative value of seed from various sources, each strain being of the same variety. Many fields of cabbage planted each year prove unprofitable because of the low yield of the crop and general market quality, a condition directly traceable to the influence of the seed strain. The majority of heads in these cabbage fields lack solidity,

have undesirable air spaces in them, do not have tightly folding head leaves, and also have unduly large cores, entailing considerable waste. Even with good soil conditions, such cabbage produces only a mediocre yield. On the other hand, it has been shown by tests of other strains that high yielding cabbage fields are influenced to a great degree by using a strain of seed which makes a solid, heavy head, tightly folding, of good flavor and keeping qualities.

The differences in yield, weight per head and money value are shown in the following table, showing the actual variations of seed strains of the same variety.

TABLE V. CABBAGE YIELDS IN RELATION TO SEED STRAINS

Strain No.	Yield per acre	Average weight per head	Value per acre	Value compared to average
	tons	lbs.		
1	10.62	4.25	$159.30	$-10.40
2	15.75	6.30	236.25	+66.55
3	9.37	3.75	140.55	-29.15
4	14.57	5.83	218.55	+48.85
5	10.42	4.17	156.30	-13.40
6	7.50	3.00	112.50	-57.20
7	12.50	5.00	187.50	+17.80
Average	11.53	4.61	$169.70	

Explanation

1. The weight of the average head represents stripped or trimmed weight.
2. The value per acre is based on a ton value of $15.00, lowest average price over a number of years.
3. State of Oregon average yield per acre 9.5 tons. (U. S. Department of Agriculture reports, 1921.)
4. Strain No. 2 is 110 percent more valuable than No. 6, and 39 percent better than the average of the seven strains. Strain No. 4 is also of considerable value.
5. Acclimated Northwestern grown strains are producing the highest yields consistent with the saving of matured heads, selected according to a definite type.

Soil. Land for late cabbage should be plowed early in the spring and regularly stirred until the time of plant setting in order that as much moisture as possible may be held in the soil. Lands which are retentive of moisture and which contain a good supply of humus, such as well-drained peat or muck soils and rich "bottoms," are producing heavier yields of cabbage than those uplands that do not hold moisture well during the dry season.

Planting. The time and manner of growing young plants is explained in Table III. Distances of planting in the field are determined largely by the market for which the crop is being grown. For the general market the best size of head is between three and five pounds, which makes it possible to set 6000 to 7000 plants to the acre. If the cabbage is grown for sauerkraut, the number set may be as low as 3650. Deep setting of plants in cloudy weather is best.

Insect Control. Considerable attention has been given by this Station to the control of insects affecting cabbage plants. Such insects as cutworms, aphis, maggots, and green worms often reduce the vitality of the plants to such a degree as to make it impossible to obtain a profitable yield. A summarized statement of methods of dealing with these insects is given in Oregon Agricultural College Extension Bulletin 325

on Insect Pests of Truck and Garden Crops, by A. L. Lovett. All cabbage growers should have a copy of this publication.

Fertilizers. If manure is available, an application of at least ten tons an acre is recommended. If commercial fertilizer is used, a broadcast application during the spring should be made following the thorough incorporation of the manure. A complete commercial fertilizer, home mixed, consisting of 150 pounds of nitrate of soda or 100 pounds of sulfate of ammonia, 400 pounds of acid phosphate, and 100 to 200 pounds of muriate to the acre, is advised as a trial fertilizer; or a complete bought-mixed fertilizer analyzing approximately 2 to 3 percent nitrogen, 8 percent phosphoric acid, and 2 to 3 percent potash can be used, applied during the final work of spring preparation of the soil.

ONIONS

The State ranks among the leading onion-growing sections of the entire country, over 350 cars being annually sold. Oregon onion fields also rank among the highest in yields of any growing areas. Factors which are responsible for this condition include: first, the planting of seed selected over a period of many years for the best market requirements; second, the use of rich soil containing a high amount of organic matter and holding moisture well through the summer; third, favorable climatic conditions for growing and curing the crop; and fourth, the comparative absence, in general, of diseases affecting the crop yield, although more acreage is apparently becoming diseased each year.

The remarkable solidity and keeping qualities, uniformity of size, shape, and color of Oregon onions are directly due to the seed selections made annually by those who are growing their own seed. Onions of the best type are selected in the spring after a long period of storage, those bulbs being taken which show no signs of sprouting at that time. These are planted in April close together in furrows two and one-half to three feet apart.

Fertilizers. In the growing of onions on the so-called beaver-dam soils, it has been the custom of growers in many cases to use commercial fertilizer in addition to manure. Few onion growers have made a check on the comparative yields of fertilized and unfertilized areas, and there are undoubtedly many tons of fertilizer applied yearly concerning which there is no record as to the influence in yield which the fertilizer may bring.

The Oregon Agricultural College Experiment Station, at the request of the onion growers, planned and carried out by means of cooperative field tests fertilizer experiments for the purpose of ascertaining the actual value of various fertilizers under individual farm conditions. Five farms were selected for these tests. The materials used included superphosphate, muriate of potash, lime, special onion fertilizer, sulfur, nitrate of soda, bone-meal, and various combinations of these materials.

The results of these tests are included in elaborate tables contained in the Second Horticultural and Crop Pest Report of the Oregon Agricultural College Experiment Station, copies of which are now exhausted. The following general summary sets forth in brief form the results obtained.

1. Beaver-dam lands and others of this character vary greatly in their chemical analyses and in their actual working amount of fertility as revealed by field tests. Each farm is an individual problem and in few cases can a rule of general fertilization be economically applied to all.

2. Yields of onions are decreased by poorly drained areas and low spots, no matter how much fertilizer may be added. Onions will not reach standard size on such ground.

3. Field tests alone are able to demonstrate the value of various fertilizers of known or unknown chemical analysis.

4. Simple field tests can easily be carried on by growers without much extra labor or expenditure of money. Such tests will supply the information desired in as good a manner as it is possible to obtain it.

5. If field tests are not conducted, it is possible to waste a good deal of money by the use of commercial fertilizers.

6. Superphosphate up to the present time has proved to be one of the most inexpensive fertilizers to use in order to increase the yield of onions. Applications of 400 to 600 pounds have been generally attended by a noticeable net increase.

7. The use of lime as a whole has not been productive of any increase.

8. Expensive applications of commercial fertilizers have shown in several cases a decided net loss.

Disease and Insect Control. Many onion fields are each year more or less injured by the ravages of pests. Among the worst diseases are smut and blight. The former, being a disease which lives over from year to year in the soil, is by far the most dreaded. It is highly contagious, being easily transmitted from one field to another by men's shoes, horse's hoofs, implements, crates, etc. The department of Botany and Plant Pathology, of the Oregon Agricultural College Experiment Station, has been conducting during the past two years experiments in the use of formaldehyde applied to the soil from a small tank carried on the seeding machine at the time of spring seeding. The results thus far obtained indicate that smut can very largely be controlled by this method properly used. In the various experimental plots, the average yield of the untreated rows was 81.5 sacks to the acre, while the treated rows yielded over 300 sacks to the acre. In some untreated rows as many as 80 percent of the onions were affected with smut, while in some of the treated rows as few as five percent were affected. For details concerning the use of the formaldehyde-drip method, address the above-mentioned department.

In the case of injury by insects, the cutworm is easily controlled by most growers who use the standard poisoned bait of bran, sirup, and paris green. (See Oregon Agricultural College Extension Bulletin 325 for formula and manner of use.) The onion maggot, however, is increasing in numbers and destructiveness annually and, up to the present time, but little work has been done by onion growers in attempting to control it. Of the many different materials tried in the past, none seem to have given satisfaction. During the past few years, however, experiments have been conducted in the use of volunteer and cull onions as a lure for the adult flies of the first generation. Results thus far have been satisfactory and the injury lessened a great deal more than by any

other treatment. Cull onions which have prematurely sprouted should be planted in the spring about seeding time, one about every 100 feet in the onion rows. Thinning should be delayed from 10 to 14 days later than normal. One week previous to thinning, the cull onions and the accumulation of maggots should be removed. At thinning time, particular attention should be paid to maggot-infested onions, which should be removed and destroyed.

BROCCOLI

The broccoli or winter-cauliflower crop is an important one in Western Oregon, being included among those vegetables which are grown extensively enough to be shipped in car-loads to eastern markets. Douglas county produces annually from 75 to 100 car-loads, while there has been a considerable increase in acreage in the vicinity of Salem. Multnomah and Clackamas counties also load out cars each year. Because of their mild winters, the coast counties particularly are becoming interested in broccoli.

In view of the importance of broccoli as a shipping crop, this Station has taken steps to investigate two vital problems connected with the production and harvesting of the crop. The first problem is that of the relative value of seed strains.

Seed Strains. At the present time there are a number of different strains of broccoli, presumably of the St. Valentine variety, to be found in the production areas. This is due to purchase of seed by growers individually instead of through an organization or from one individual seed grower. Added to this, also, is the fact that several growers have been growing their own seed and, in doing so, are bound to differ, one from the other, in the selection of the type plants and the quality of seed produced. Consequently there has been in the past quite a wide difference between the value of broccoli fields because of the different seed strains grown. Serious losses have been experienced by some growers due to deteriorated strains of little value. One grower suffered a loss of over $2000 through the failure of the plants to make marketable heads.

It is recommended that individual growers do not make a practice of growing their own seed. It is better that this work should be done by one or two seed-growing specialists who are thoroughly familiar with the methods of selecting seed type plants and their care later on.

Table VI shows how the market quality of broccoli crops varies according to the seed strain.

TABLE VI. GRADES OF BROCCOLI IN RELATION TO SEED STRAINS

Strain No.	Percentage of crop			Percentage of crop cut first month
	Grade 1	Grade 2	Grade 3	
	%	%	%	%
1	88.0	10.0	2.0	44
2	16.3	32.6	51.0	16
3	72.0	28.0	0.0	8
4	76.0	10.0	13.0	56
5	75.0	0.0	25.0	50
6	60.0	28.0	12.0	44
7	70.0	11.7	17.0	11
8	73.0	20.0	6.60	42
9	80.0	10.0	10.0	36
10	47.0	34.0	18.0	21
11	80.0	19.0	1.0	36
12	53.0	23.0	23.0	80

The work of testing the value of seed strains is being continued during 1921-1922.

The most desirable type of broccoli plant and head is as follows: Plant large, vigorous, 36 inches high, branches close to ground, stem short, thereby permitting covering to prevent freezing; plant leaves three times as long as wide, averaging 27 to 35 inches by 9 to 10 inches, center, midrib prominently white; color of leaves, upper side dark bluish green, under side slightly lighter shade; head leaves or jacket showing tendency to curl over head, protecting it; curd compact, showing no divisions; color clear white; head measuring 6 to 8 inches horizontal diameter, vertical section rounded and deep; head showing no evidence of leafiness or riciness.

Maturity of Broccoli in Relation to Harvesting. An important factor in the ability of broccoli to withstand long-distance shipment with the least deterioration in quality is the maturity of the crop at the time it is harvested. Car-loads of broccoli are shipped from Western Oregon as far as New York City, necessitating a period in transit of 12 to 18 days. It is very necessary, therefore, that such a perishable product be harvested when in the best condition for long shipment, and that it be gathered, graded, and packed with the greatest care to avoid injury.

With the present freight rates, it is evident that it is undesirable to entail heavy expenditures for transportation, icing, etc., unless the broccoli is loaded when in the proper state of maturity. Over-ripeness of the curd (head) at harvesting time results later in a breaking down of the curd, separation of the various parts, loss in weight, limpness and wilted appearance following the removal of the product from the car. On the other hand, heads which are cut at a proper stage of maturity hold up in a superior manner when shipped. This is shown by the data presented in Table VII.

There is a tendency on the part of some growers to allow heads to get too old before cutting them, the assumption being that they will get larger with every additional twenty-four or forty-eight hours. As a matter of fact, the maturity of the heads, with their superior carrying qualities, is sacrificed for a possible increase in weight.

In the mind of the dealer to whom the crop is sold the most important characters of value in broccoli heads are: (1) whiteness of the curd; (2) solidity of the curd, showing no separation of its natural divisions; (3) size of the curd; (4) a green "jacket" of leaves encircling the head; (5) curd free from blemishes, black spots, finger bruises, molds, etc.

In order that data might be obtained concerning the behavior of heads which were cut in varying stages of maturity, certain crates of broccoli were harvested and then submitted to temperatures, in cold storage, as nearly as possible those under which broccoli are shipped to eastern markets.

The terms used in Table VII are defined as follows:

Heads are in "prime condition" when the curd is solid, showing absolutely no division, tight, color clear white.

Heads are "slightly over-ripe" when the curd shows some slight signs of segregation but is not plainly divided.

Heads are "over-ripe" when the curd plainly shows natural divisions, yet is turgid.

TABLE VII. SHRINKAGE OF BROCCOLI HEADS ACCORDING TO VARIOUS DEGREES OF MATURITY WHEN HARVESTED.

Lot No.	Prime condition	Slightly over-ripe	Over-ripe	Length of test
	%	%	%	days
1	15.8	22.8	25.5	11
2	10.5	17.5	23.0	12
3	14.0	22.0	31.0	17

The average loss in weight of the heads in Table VII was approximately 8 to 9 ounces a head of those harvested in "prime condition," 13 to 13.5 ounces of those "slightly over-ripe," and 16.9 ounces of those harvested "over-ripe." Figuring an average of ten heads a crate for the entire car-load, the loss to the crate of the various degrees of maturity would be, respectively, 5 pounds, 5 ounces; 8 pounds, 2 ounces; and 10 pounds, 9 ounces. There is therefore a danger of increasing the shrinkage of a crate just twice the normal amount by allowing the heads to remain uncut in the field. Added to this also is the fact that the appearance of heads harvested when over-ripe damages their chances of sale at a profit for the grower.

It is recommended that broccoli be harvested preferably when immature rather than when the heads show any signs of curd separation. By closer observation of the development of the heads in the field, a larger percentage can be marketed in "prime condition," thus insuring satisfaction to both grower and buyer and the greatest profit.

Grading and Packing. In order that uniformly packed crates of broccoli be shipped, certain grades have been adopted which it is advisable for growers to follow closely:

Grade No. 1. Large. This grade shall consist of sound, reasonably perfect heads which are of one type, symmetrical, well blanched, and compact. Specimens in this grade shall show no signs of withering and shall likewise be free from leafiness, riciness, or segmented curds. They shall be practically free from blemishes such as discoloration from sunshine, freezing injury, disease, or injury from mechanical means.

Each head shall measure no less than 5 nor more than 9 inches in diameter, and crate shall contain not less than 6 nor more than 12 heads. Crates shall contain heads of uniform size.

Jacket: A sufficient, but not excessive amount of jacket leaves shall be left to protect the head. This jacket shall be neatly trimmed to extend one inch above apex of head.

All broccoli of this grade shall be packed in a new container. Each container shall be stamped or branded Oregon Broccoli, Grade No. 1, Large. This grade must be indicated on the invoice, or otherwise declared.

Grade No. 1. Small. This grade shall consist of fine heads of broccoli, which are of one type, reasonably perfect, symmetrical, well blanched and compact. Specimens in this grade shall show no signs of withering, and shall likewise be free from leafiness or segmented curds. They shall also be practically free from blemishes such as discoloration from sunshine, rain, freezing injury, disease, or injury from mechanical means.

Jacket, same as No. 1. Size: In this grade are included heads down to four inches. The maximum pack shall be 13 to 15 heads to the crate. Crates shall be packed with heads of uniform size.

Term Definitions. "Reasonably perfect:" a curd smooth in outline, white, and showing no signs of segmentation.

"Leafiness:" the disposition of some heads to show leafy growth between the segments of the curd.

"Riciness:" an appearance like rice grains on surface of curd.

"Practically free:" the appearance shall not be injured to an extent disclosed by a casual examination of the lot.

"Diameter:" average horizontal dimension of head proper.

For further details concerning the growing and marketing of broccoli, write for circulars 148 and 171, Oregon Agricultural College Extension Service.

TOMATOES

Investigational work with this vegetable has dealt largely with factors which influence early ripening and total yield of fruit. Based on these findings the following recommendations are made in order to summarize the data.

Varieties. It is necessary to select a variety that is naturally productive of early ripening fruit of good shape, color, and size. It is realized that there are many hundreds of so-called varieties which have never been grown on trial at Corvallis. Among those which have been used from year to year, however, the following have been most productive of ripe fruit: Earliana, Bonny Best, John Baer, Jewel. In each case the value of the variety has been largely dependent on the strain grown, in so far as early fruit of good grade is concerned. Some Earliana strains grown at Corvallis have produced unusually good yields of early fruit of good quality, while other strains of the same variety have been very inferior, bearing tomatoes so rough and unattractive as to make it impossible to pack very many in Grade No. 1. Bonny Best and John Baer strains up to the present time have been more uniform.

TABLE VIII. EARLY AND TOTAL YIELDS OF TOMATO VARIETIES, ONE-EIGHTH ACRE

Variety	Yield to Aug. 31	Yield to end of season
	lbs.	lbs.
Earliana	360	2611
John Baer	303	2415
Jewel	206	2024

Plants. Investigations with different grades of plants show conclusively that the date for ripening of the first fruits is very much earlier from large, well-grown, vigorous plants than otherwise, also that the fruit picked from such plants during the first month or so of the harvesting season is largely in excess of the yield from small, puny seedlings. Largest early yields have been obtained from pot-grown plants as well as from those which were box- or frame-grown, disturbed but little when transplanted to the field. Methods of plant growing differ according to the location of districts, general methods being summarized in Table II.

Plant Production. Many hundreds of plants are lost annually from both disease and insect attacks. "Damping off" fungus is the worst enemy of young seedlings. Methods for control of this disease are found elsewhere in this circular. Cutworms and flea beetles are the most injurious insects. Satisfactory results in controlling both of these have been obtained on the Station grounds by using the standard poison mash for the worms and dusting the plants with "nico-dust," or "All-in-one" dust, or spraying with bordeaux mixture to repel the beetles. Plants should be thus protected at the time of transplanting to the field.

Control of Dry Rot. The rot which occurs at the blossom end of the fruit, called "point rot," "blossom end rot," or "dry rot," is one of the worst troubles in tomato growing, particularly when the crop is grown on land that does not hold moisture well or which cannot be irrigated. The rot is particularly bad during dry seasons. From all indications, irrigation is helpful in reducing the number of fruits subject to rot. In field trials conducted during 1918 and 1919, plots of tomato plants which were irrigated showed a very small number of fruits affected with rot as compared with the dry plots. Results of these tests are briefly shown in Table IX.

TABLE IX. RELATION OF IRRIGATION TO DRY ROT.

Percentage of Affected Fruits

Variety	Heavy irrigation	Medium irrigation	Light irrigation	No irrigation
Earliana	0	8	—	17
John Baer	0	3	9	40
Jewel	0	—	15	31
Bonny Best	0	—	12	19

Maturity of Fruit. Being a quickly perishable vegetable, it is very important that tomatoes be harvested in the right stage of maturity or ripeness so as to arrive at destination in good order. Growers should realize the rapidity with which the fruit ripens during the summer after being harvested, and should pick the tomatoes according to the distance of their market.

Table X shows the changes which may be expected to take place after harvesting.

TABLE X. RIPENING OF TOMATOES AFTER PICKING

Condition of fruit when harvested.	Condition of fruit October 5			Remarks
	Lot 1	Lot 2	Lot 3	
Hard green	33⅓% pink 66⅔% red	50% green 50% green pink	50% green but turning 50% green pink	Color changes not uniform
Green, turning	100% red	100% red	100% red	Color changes uniform; solid fruit
Green pink	100% red	100% red	100% red	Color uniform; solid fruit

Explanation:
Lot 1 were unwrapped; Lot 2 were wrapped in light paper; Lot 3 in heavier paper.

ASPARAGUS

This vegetable is of permanent value in every farm garden. It is one of the earliest crops harvested in the spring, and is practically an assured crop each year. Asparagus adapts itself readily to almost all climatic conditions of the State.

It is essential to get large, first-grade seedlings. Experiments have shown that the large roots of one-year-old plants are preferable to any others. The newest variety of asparagus is Washington, a high-yielding, pedigreed strain of superior vigor, especially suitable for culture in places where asparagus rust is liable to cause serious damage. Those especially interested in this crop should obtain circular No. 7 of the Office of Truck Crop Diseases, Bureau of Plant Industry, Washington, D. C., regarding strains of asparagus. A circular on asparagus culture is also available from the Extension Service of the Oregon Agricultural College.

RHUBARB

This vegetable is being grown profitably in the State in two ways, one being the ordinary field crop harvested during April, May, and June, and the other being the hothouse rhubarb, which is marketed during February, March, and part of April. Crops of the forced rhubarb grown at the Station and by individual growers indicate that a yield of two pounds to the square foot of area can be obtained. Market prices during the past three years vary from 18c to 10c a pound. This makes a good vegetable to be grown under benches of a greenhouse or in a shed constructed and heated for the special purpose of rhubarb forcing.

Crops of field rhubarb are most profitable when taken from vigorous plants grown on rich sandy "bottoms" with or without irrigation. The names of varieties of rhubarb are not so important as the actual strain of plants which are set out, which should be productive of stalks of a good red color and vigorous growth.

BEETS

The best strains of table beets are those which show no signs of light zones in the interior flesh, but which are dark red throughout, making an acceptable beet for the cannery and general market. Early Model is one of the best having these superior characters. Fourteen strains of beets were recently tested on the Station grounds, all of them varying greatly in their value as to color, uniformity of shape, and trueness to type. Very few of the strains were typical in their catalogue description. Some, claimed to be blood red, were so zoned with light rings as to be practically unmarketable.

Attention is called in Table XI to the desirability of making two plantings of beet seed, one for summer use, and the second planting for fall and winter marketing.

LIMA BEANS

While it is not possible in many parts of the Northwest to grow to maturity varieties of true Limas, yet there is no reason why the Limas mentioned in the recommended list of varieties should not be widely planted. The Oregon pole Lima, which is a large white bean and re-

lated to the scarlet runner bean, can be matured in most growing sections where beans can be matured at all. The butter bean, also mentioned in the list of varieties, is also an excellent bean, equally as good as any Lima to be found on the markets from the South. Both of these beans are worthy of a place in any garden where beans can be ripened, and the growing of these varieties by Northwest gardeners would mean a saving of thousands of dollars expended annually for California Limas.

HEAD LETTUCE

During the past few years the business of growing lettuce in the Northwest has grown extensively. Large numbers of car-lot shipments are now made annually to Eastern points from different sections of Oregon, Washington, and Idaho. The varieties most widely grown are New York and Iceberg, with the former predominating in acreage. Of very great importance to the grower is the planting of a strain of seed which will insure a crop of solid heads and a high degree of uniformity throughout the field. There are four seasons of the year when lettuce is best grown and finds a ready demand; first, the spring crop matured in cold-frames; second, the first outdoor crop grown by setting out plants in the field; third, the fall crop grown from seeding in the middle of the summer, the plants being irrigated; fourth, the late fall crop grown in frames, which ends the season. Manure in abundance and a quickly available fertilizer have a great deal to do with success. Detailed directions for growing are found in Table XI.

CAULIFLOWER

This vegetable is best grown for fall marketing, the dates for seeding and transplanting being suggested in Table III. The crop may prove to be entirely unsatisfactory unless considerable care is taken in buying seed. Only the best imported seed should be used. On the Experiment Station grounds in 1921, the greater portion of a block of cauliflower produced heads of various colors other than white, as well as heads which were "leafy" and generally unmarketable. The plants were vigorous and up to heading time showed every indication of producing good cauliflower. Another block of cauliflower growing under identical conditions produced heads almost 100-percent marketable. The plants were exceptionally vigorous, with heads large and well protected by head leaves curled over the center of the plant.

In growing cauliflower, the plants must be kept steadily growing without check. In transplanting to the field shading each plant with a shingle is helpful in preventing a set-back, especially if the work has to be done during warm weather.

Maggots often cause considerable loss to young plants in the seed bed and later to plants which have been set in the field. Screening the plant beds with cloth gauze becomes necessary, and transplanting of the plants to the field should be made in soil which has had a good dust mulch for some time previous to the transplanting.

CELERY

With proper management and careful attention to details, very good celery is being grown in all parts of the State except the areas

Fig. 12. A field of well-grown celery showing the crop in various stages of maturity. Upper left shows celery already harvested; celery in upper right is boarded; foreground celery is not yet large enough to be blanched.

which are very warm in the summer. The crop is capable of large returns under skillful handling. The factors essential to a good crop are: first, a high-grade seed strain; second, strong, well-grown plants; third, ample supply of water for irrigation; fourth, soil which is adapted to the needs of the crop. Cultural directions are to be found in Tables II and IV.

Investigations show that it costs from $375 to $450 to grow and market an acre of celery. Gross returns should average 1600 to 2000 dozen bunches, of an average value of 60 to 75 cents a dozen.

Many cities of the State offer opportunities for marketing home-grown celery if it is first-class, and there are also opportunities for car-lot shipments into other states.

SWEET CORN

The greatest factor in the growing of this vegetable for earliest yields is the use of acclimated seed which has been saved from selected ears. Growers will find that good strains of Portland Market, and Early Market, as well as Golden Bantam and Howling Mob, are sufficient to produce crops of corn that can be harvested during the entire season. The corn ear-worm is an enemy in corn growing, and should be controlled as far as possible by all corn growers in order to rid the State of the pest. Oregon Agricultural College Extension Bulletin 325, mentioned elsewhere, gives details as to the manner of checking this insect.

TABLE XI. DETAILED CULTURAL DIRECTIONS FOR MISCELLAN EOUS VEGETABLES

Vegetable	Date of seeding	Hills or drills	Distance between rows	Amt. seed per 100 feet row	Depth of seeding	Distance thinning	When maturing	Vegetables preceding (p) or following (f)
Beans, bush	May 1-July 10	D	inches 28-32	1 lb.	inches 2-3	inches —	July 20-frost	First seedings f. by turnips, radish or lettuce.
Beans, pole	May 15-30	H	36	1 lb.	2	3 or 4 plants per hill	Aug. 1-frost	———
Beans, Lima	May 15-20	H	36	1 lb.	2	3 or 4 plants per hill	Sept. 10-frost	Requires whole season.
Beets, early	Apr. 10-20	D	18	2 oz.	1	2-3	July 1	f. by late cabbage, broccoli, lettuce, cauliflower, turnips.
Beets, late	June 1-30	D	18	2 oz.	1	3	Sept.	p. by green onions, spinach, lettuce.
Carrots, early	Apr. 10-20	D	18	½-1 oz.	½	2-3	July 10	f. by turnips, spinach, radish, fall sown peas or cabbage.
Carrots, late	June 1-25	D	18	½-1 oz.	½-1	3	Sept.	See late beets.
Chard, Swiss	Apr. 10-20	D	18	2 oz.	1	6	July 10	Chard producing continuously.
Corn, sweet	May 1-June 20	H or D	36	1 pt.	1½-3	3 per hill	July 25-frost	Seeding should be successive for production to frost.
Cucumbers	May 10-June 10	H	72	½ oz.	1	3-4 per hill	Aug. 1-frost	———
Kohl-rabi	Apr. 10-June 20	D	12	1 pk.	½	3	June 10-Sept. 10	Early summer crop f. by late lettuce or beans, late carrots, etc.
Lettuce, head	Apr. 10-July 15	D	12-16	½ oz.	½	10-12	July 1-Nov. 20	Crop preferably grown in regular succession for harvesting.
Muskmelons	May 15-25	H	72	½ oz.	1	3-4 per hill	Aug. 25-frost	All season required.
Onions from seed or plants	Apr. 10-25	D	14	½ oz.	½-1	3	Sept. 10-Oct. 20	All season required.
Onions (green) from sets	March 20-Apr. 10	D	14	2 lbs.	1	2	June 1-30	See "early beets."

TABLE XI. DETAILED CULTURAL DIRECTIONS FOR MISCELLANEOUS VEGETABLES—Continued

Vegetable	Date of seeding	Hills or drills	Distance between rows	Amt. seed per 100 feet row	Depth of seeding	Distance thinning	When maturing	Vegetables preceding (p) or following (f)
Parsnips	Apr. 25-May 15	D	18	½-¾ oz.	1	3	Sept. 25	All season required.
Peas	Fall. Sept. 20 Spring. Mar. 15-Apr. 25	D	24-30	1 lb.	1½-2	—	May 25-July 25	f. by cabbage, cauliflower, sprouts, celery, beans, lettuce, spinach, etc.
Pumpkin	See winter squash	—	—	—	—	—	——	——
Radish	Mar. 20-Sept. 10	D	12	1 oz.	½-1	1-1½	Successively	p. or f. many vegetables.
Salsify	See parsnips	—	—	—	—	—	——	——
Spinach	Mar. 20-Apr. 15-Fall. Sept. 1-Oct. 1	D	12	1 oz.	1	—	May 1-June 25	See "Peas."
Squash, summer	May 10-25	H	36-48	½ oz.	1	3 or 4 per hill	July 20	Continuous production.
Squash, winter	May 15-25	H	96	½ oz.	1	3 or 4 per hill	Sept. 25	——
Turnip	Spring. March 20-April 20-Fall. Aug. 20-	D and broadcast	12	½ oz.	½	2-3	June 1-Nov. 30	Early crop f. by late beans, lettuce, celery, late crop p. by lettuce, peas, green onions, beets or carrots.

Note 1: See other tables for details of growing celery, cabbage, cauliflower, sprouts, tomatoes, eggplant, peppers, kale, lettuce, and broccoli.
Note 2: Dates of seeding entirely dependent on season, locality, and kind of seed. Dates above are average for Western Oregon.
Note 3: Successions of crops largely dependent on irrigation facilities.

VEGETABLES IN COLD STORAGE

Various vegetables have from time to time been placed in the cold-storage plant of the department of Horticulture for later marketing. Observations have been made concerning the shrinkage of these crops during the storage period and their condition at the end of the storage. It must be taken into consideration to some extent that this cold-storage plant was not operated from 10:00 p.m. to 7:30 or 8:00 a.m. Therefore the average temperature for the twenty-four hours was between 38° and 42° F., although probably several degrees lower from 9:00 a.m. to 10:00 p.m.

In every case vegetables were fresh and were put into storage as soon after harvesting as possible. Efforts were also made to keep all specimens free from bruises in this handling.

Celery. This vegetable was blanched before being put into storage. Some lots of celery had their leaves partly trimmed, while others were untrimmed. Still other lots were washed or unwashed, respectively. The celery unwashed is here called "rough."

The period of storage was from 10 to 14 days. The average loss of the "rough trimmed" bunches was 10 percent; that of the "rough untrimmed," 19 percent. Some bunches of the "rough trimmed" showed as little loss as 7 percent. Again, some of the "rough untrimmed" lost only 10 percent. The leaf trimming toward the top of the plant evidently reduced the total amount of shrinkage. There was a noticeable evidence of less wilting of the several bunches which were trimmed.

The average loss of the celery which was washed and trimmed was 9 percent, lowest and highest losses being 5 percent and 15 percent, respectively. The washed and untrimmed celery lost 15 percent with variations between 10 and 21 percent. There was a general disposition on the part of the trimmed bunches to be less wilted at the end of the storage than the untrimmed.

Eggplant. This vegetable requires extreme care in being handled for storage, due to the readiness with which it is bruised. Rot and mold soon begin to decay injured specimens. If the "eggs" are kept in dry sawdust or excelsior, they will be less bruised and keep longer. The storage loss during 26 days is not great, averaging, 4.5 to 5.0 percent. The best fruits without bruises kept the longest and showed the least shrinkage. Soundness, therefore, depends on careful handling from field to storage.

Cabbage. The period of storage during which observations with cabbage were made varied from 24 to 48 days. For the first half of the storage, there was a shrinkage loss of 4.0 to 4.5 percent, and after 48 days, an average loss of 10.0 to 11.0 percent, the variation being from 6.0 to 20.0 percent. Solidity of heads to be stored is essential. They should also be carefully handled, even though they are solid.

Cauliflower and Broccoli. Success in keeping these vegetables in storage for any length of time depends largely on the maturity and character of the individual head. There is wide difference in this respect between the heads. There is a general disposition for the broccoli

leaves or "jacket" to turn yellow and drop off during storage, even though the "curd" still remains in good condition. The average shrinkage loss in 18 days varied from 9.0 to 13.0 percent, good heads keeping nicely for that period of time.

Muskmelons. The salability of melons after a period of storage is dependent on their condition when first handled. During a period of 21 days the average loss was uniformly 6.0 to 7.0 percent with most of the specimens firm and salable. These figures were confirmed by several different lots of melons stored at various times.

Leaf Lettuce. Loose leaf lettuce which is washed before storage will lose comparatively little weight during a period of 11 days, according to tests made. This lot of lettuce was in good marketable condition at the end of that time. Some lots of lettuce having been unwashed were unmarketable before seven days and had lost 11.0 percent of their original weight. Indications are that it pays to wash lettuce before it is stored.

Green Peppers. During a period of 26 days with temperature varying from 38° to 40° F., the average loss of fruit was 9.0 percent. With the exception of a few specimens which were slightly soft, all peppers were in good marketable condition at the end of the storage period. Tests were not made for any further length of time.

Tomatoes. Field tomatoes which are handled with care keep well in cold storage and lose but little weight. The average loss was 2.0 percent during a period of 26 days. There is but little disposition for any coloration during this time. Care must be taken after storage to keep the fruit from being exposed to high temperatures; otherwise it will "sweat" readily and break down more quickly.

Root Crops. As a general rule, carrots, beets, and similar roots do not adapt themselves to cold storage. They are preferably kept under conditions where there is more moisture coming directly in contact with the roots themselves, such as in earth storage. There is a wide variation between the moisture loss of individual roots. Tests have been made with carrots showing as high a loss after three weeks as 22.0 percent. Some roots were unmarketable after two weeks and showed a loss of 18.0 percent.

Summary. As a general summary, it must be considered that while the temperature maintained in the plant was not always approximately 34 percent, yet all of the vegetables mentioned were stored under similar conditions, hence the possibility of comparison of their respective shrinkage.

It was apparent in every case that the most profitable specimens to be held in storage were first-grade, carefully handled products, in good condition and free from defects. With these specimens the shrinkage was smaller and the period of possible holding considerably longer than otherwise.

BIBLIOGRAPHY

Requests are frequently received for suggestions regarding literature on vegetable gardening; hence the following list is appended. In addition, names of standard reference books will be furnished on application.

JOURNALS

The Market Growers' Journal, Louisville, Ky. (Official organ of the Vegetable Growers' Association of America.)

OREGON AGRICULTURAL COLLEGE BULLETINS

The Home Vegetable Garden—Oregon Agricultural College Extension Bulletin 287.

Seed Sowing and Spring Transplanting in the Vegetable Garden—Oregon Agricultural College Extension Bulletin 290.

Insect Pests of Truck and Garden Crops—Oregon Agricultural College Extension Bulletin 325.

OREGON AGRICULTURAL COLLEGE MIMEOGRAPHS

Asparagus.
Rhubarb.
Broccoli Growing.
Broccoli Harvesting.
Growing and Marketing of Late Cabbage.
Celery.
Onions.
Head Lettuce.
Tomatoes.
Tomatoes Under Glass.
Spinach.
Details of Small Greenhouse.
Mushroom Growing.
Varieties of Vegetables for Home Planting.
Horseradish Growing.
Mint Growing.
Cucumbers Under Glass.
Hotbed Construction and Management.
Fertilizers for Truck Crops.

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