Vegetable Seed Production

8.1 Introduction

Vegetable seed production is a specialized farming enterprise which is well suited to the climate and soils of the Pacific Northwest. There is considerably more risk for the grower, but the economic return is often greater for vegetable seed crops than for the other seed crops grown in the region. Vegetable seeds are grown under contract with seed companies since there is no open market production. Inputs for vegetable seed crops are greater than for most other seed crops. There is lots of hand labor and few herbicides for weed control.

Vegetable seed crops are grown in Oregon’s Willamette Valley, Treasure Valley, and near Madras, in Washington’s Columbia Basin and Skagit River Valley, and in Idaho’s Treasure Valley and Snake River Valley. The historical development of the Pacific Northwest vegetable seed industry has been outlined by Rackham (2002). The vegetable seed industry in Oregon has developed to its current size within the last two decades (Fig. 8.1). The diversity of vegetable seed crops grown in the region is illustrated in Table 8.1.

![Figure 8.1. Vegetable and flower seed crop acreage trends in Oregon. Most of the reported acres are for vegetable seed crops.](image-url)
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Table 8.1. Vegetable seed crops of the Pacific Northwest.

<table>
<thead>
<tr>
<th>Oregon</th>
<th>Washington</th>
<th>Idaho</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrot</td>
<td>Carrot</td>
<td>Carrot</td>
</tr>
<tr>
<td>Hybrid cabbage</td>
<td>Hybrid cabbage</td>
<td>Onion</td>
</tr>
<tr>
<td>Radish</td>
<td>Radish</td>
<td>Green Bean</td>
</tr>
<tr>
<td>Onion</td>
<td>Green Bean</td>
<td>Hybrid sweet corn</td>
</tr>
<tr>
<td>Leek</td>
<td>Onion</td>
<td></td>
</tr>
<tr>
<td>Table Beet</td>
<td>Dill</td>
<td></td>
</tr>
<tr>
<td>Hybrid squash</td>
<td>Turnip</td>
<td></td>
</tr>
<tr>
<td>Pumpkin</td>
<td>Parsley</td>
<td></td>
</tr>
<tr>
<td>Cucumber</td>
<td>Kale</td>
<td></td>
</tr>
<tr>
<td>Parsley</td>
<td>Beet</td>
<td></td>
</tr>
<tr>
<td>Turnip</td>
<td>Spinach</td>
<td></td>
</tr>
<tr>
<td>Watermelon</td>
<td>Leek</td>
<td></td>
</tr>
<tr>
<td>Broccoli</td>
<td>Hybrid sweet corn</td>
<td></td>
</tr>
<tr>
<td>Rutabaga</td>
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<td></td>
</tr>
</tbody>
</table>

8.2 Carrot

Carrot seed is produced under irrigation in the Central Basin of Washington, near Madras, and in the Treasure Valley of Idaho and Oregon. Methods of carrot seed production include: (1) root to seed, and (2) seed to seed. The seed to seed method is the most commonly used method.

Fields are irrigated prior to planting in August. A pre-plant herbicide such as Treflan is applied. The crop is sown at 1.5 lb./acre at a seeding depth of ¼ to ½ inch. The row spacing ranges from 22-34 inches. The crop is irrigated immediately after planting. A common practice is to hill up soil around roots to prevent frost heaving. The crop is thinned in the following spring either by hand or mechanical means.

Carrot seed crops must be isolated from wild carrots. Volunteer carrots must also be controlled in carrot seed fields. For hybrids, the isolation distance is 2-3 miles between fields while for open-pollinated cultivars, the isolation distance is ½ mile. Pollination is done by honey bees and sometimes by alkali bees.

Nitrogen fertilizer needs (160 lb./A) for carrot seed production are allocated in the following manner; ½ applied preplant and ½ applied in spring. High water and nitrogen
causes lodging in carrot seed fields. Phosphorus (60-120 lb./A), Potash (60-120 lb./A) and Sulfur (20 lb./A) are also applied.

Lygus bugs are an important insect pest of carrot seed crop and can reduce seed yield. Lygus can be controlled at the economic threshold of 1 bug per umbel with insecticides.

Bacterial blight is a disease that infects umbels and results in seed contamination. Other seed borne diseases include alternaria leaf blight and alternaria black rot. White mold attacks roots and can cause wilting of the crop.

Harvesting is a problem in carrots because of the 3 economically important umbel orders. Umbels that belong to each of these umbel orders mature at different times. The primary or king umbel matures first, followed by the secondary umbel, and finally, the tertiary umbels mature last. Swathing is done when the primary and secondary umbels are brown but before the tertiary umbels mature, usually between mid-August and early September. Highest seed quality can be attained when seed moisture contents have fallen to below 20% (Steckel et al., 1989). Carrot seed crops are dried for 3-7 days in windows and then combined.

In the conditioning of carrot seed, debearders are used to remove spines from the seed. The seed is then cleaned with the air-screen cleaner and gravity table. An indent cylinder is used to remove remaining stems. Some seed companies use size graders to improve germination but this practice is not always helpful.

Germination of carrot seed is low in some production years, and is accompanied by an increased number of abnormal seedlings. Early harvest may contribute to this problem as seeds are brown in color and appear to be mature, but the embryos themselves remain immature.

8.3 Onion

Onion seed crops are grown in the Columbia Basin, Treasure Valley, and Willamette Valley. Gross income can reach $12,000 per acre, the highest for any field crop in Oregon. Recent prices for hybrid onions are $10-16 per pound and $4-6 per pound for open-pollinated onions. Both hybrid and open-pollinated cultivars are grown in the Pacific Northwest. The predominant type grown here for seed is the long-day onion. Onions are a biennial crop; during the 1st year the bulbs develop and in the 2nd year, stalks and seed are produced.

A weed free seed-bed is need for seed production of onion as the plant itself is a poor competitor with other plants. Preplant application of herbicides such as Treflan are a standard practice.

The stand is usually established with bulbs rather than seeds. Bulbs are planted between May and July. Row spacing for the bulbs are 18-24 inches.
Fertilizer applications in the 1st season include: 40-50 lbs./acre Nitrogen and 88-178 lbs./acre Phosphorus, 90 lbs/acre potash, 50-100 lbs. N/acre in the 2nd season.

Pests include bulb infections and scape blight diseases which are caused by *Botrytis* spp. Benlate fungicide used for control.

Honey bees are stocked in the field for pollination at 6 hives per acre.

Harvesting onion seeds are an expensive operation. Onion seed crops are often cut by hand and air-dried, and the crop is threshed. Seed heads are cut, leaving 6-8 inches of stem attached to the head. This will permit continued development of the seed during the drying process. Hand harvest is very expensive. Mechanical harvesting by swathing onto paper is also practiced. The crop is dried on the paper and then combined. Yields of onion seed crops range from 300-1000 lb./A.

8.4 Cabbage

Cabbage seed crops are grown in the Skagit River Valley and in the Willamette Valley. Crops may either be direct-seeded or started from transplants.

Heads are split with knife in early winter to prevent head formation. The crop will vernalize at the 13-15 leaf stage of development.

For cabbage seed crop weed control it is important to select clean fields. Treflan is applied for preemergence weed control. Goal is used for broadleaf weed control in transplanted cabbage seed crops.

Fertility management in cabbage seed crops includes 22 lbs N/acre in fall and 60 lbs N/acre in spring.

8.5 Radish

Radish seed crops are produced in Columbia Basin, Willamette Valley, and in the Treasure Valley. There are 2 major types grown in the Pacific Northwest: 1) radish and 2) daikon, an oriental winter radish. Both types have open-pollinated and hybrid cultivars. Recent prices for radish seed are $3.75 per pound for hybrids and $0.80 per pound for open-pollinated cultivars.

The most common time for planting of radish seed crops is from March 15 to April 15. Fields are pre-irrigated and Treflan herbicide is applied prior to planting. The crop is sown at 4 lb./acre in 22 inch rows.

Radish seed crops need to be isolated from wild radish. Isolation distance from other radish seed crops is 0.5 to 2 miles and from daikon radish seed crops, the distance is 1 to 2 miles. Pollination of radish seed crops is accomplished by honey bees.
Nitrogen in radish seed production is applied at 160 lbs. N/acre; 2/3 preplant and 1/3 mid-May. Phosphorus is applied at 80 lbs./acre, potash at 80 lbs./acre and sulfur at 25 lbs./acre.

Pests of radish seed crops includes two major insects; cabbage maggot and cabbage aphid. Black rot caused by *Phoma lingam* and white rot are diseases that can affect radish seed yield.

The crop is windrowed and combine harvested between late August through early September. Good post-harvest management of radish seed crops does not permit plowing of the crop residue after harvest. This action will create a volunteer radish seed problem that will contaminate other crops and potentially, future radish seed crops for many years.

8.6 Hybrid Squash

Cucurbit seed crops grown are more important in Oregon that in Washington or Idaho. These include hybrid squash, pumpkin, cucumber, and watermelon. Hybrid squash is the most widely grown cucurbit seed crop in Oregon. There are 2 types of hybrid squashes grown in Oregon: 1) zucchini, a summer squash, and 2) Hubbard, a winter squash. All cucurbit seed crops are grown with the aid of irrigation.

Hybrid squash seed crops must be planted on well-drained, fine-textured soils. The crop is sown in hills or beds to permit cultivation. One row of male plants are sown alternately with three rows of female plants. Hybrid squash seed crops are planted in May when soil temperatures are warm enough to insure maximum germination. Isolation distance for hybrid squash seed crops is 1½ to 2 miles between cultivars.

Fertilizer management for hybrid squash seed crops include: Preplant: 30 lbs. N/acre, 50 lbs. P_{2}O_{5}/acre, 50 lbs. K_{2}O/acre, and 20 lbs. S/acre. Apply N at 50 lbs./acre when runners spread.

*Diabrotica* spp. is a major insect pest of hybrid squash seed crops. Weed control for hybrid squash seed crops is achieved by cultivation as no herbicides are available.

Honey bees are used in pollination of hybrid squash seed crops. Hives are stocked in fields at 1 to 2 hives/acre. The growth regulator ethephon is applied to convert male flowers to female flowers on female plants and to shorten the length of plant internodes. The conversion of flowers by ethephon prevents self-pollination.

Hybrid squash seed crops are harvested by the wet seed method. In October, ripe fruit are raked together and a special combine picks up and crushes the fruit. A special implement known as a crowder separates the male rows from the female rows.

Harvest steps for hybrid squash seed crops:
1) Fruit is raked into windrows.
2) Fruit is picked up by a modified potato belt.
3) Fruit is crushed in the combine and fruit is separated from the pulp (containing seeds) by use of rotary screens.

Seed of hybrid squash are conditioned by the wet seed method. The crushed fruit yields a seed and slime mixture. This mixture is allowed to ferment for several days in order to facilitate slime removal. The slime is washed from the seed. Then seed is dried in a rotary dryer at 95°F for 8 to 12 hours. The seed is dried to 6% seed moisture content and is then cleaned with an air-screen cleaner, followed by a gravity table.

8.7 Hybrid Sweet Corn

Southwestern Idaho accounts for 85 to 90% of US sweet corn seed production. Idaho grow between 12,000 to 18,000 acres of sweet corn for seed each year. There are 2 types of hybrid sweet corn grown for seed in Idaho:
1) sugary (SU), accounts for 60% of production
2) shrunken II (SH-2) or super sweet, accounts for 40% of production.

Hybrid sweet corn seed crops are sown in late April to early June. The crop is sown immediately after the seedbed is irrigated and planted 1 inch below the soil moisture line in the seedbed. The inbred lines are sown at plant populations ranging from 20,000 to 40,000 plants per acre. One row of pollen parents are alternated with four rows of seed parents.

Nitrogen is incorporated into the seedbed prior to planting. The crop uses nitrate type N for side dressing, since ammonium type N encourages the development of stalk rot disease. The N rate depends on soil test results as well as the residual N present in the soil from the previous crop (Table 8.2). Phosphorus and potash applications depend on soil test results.

<table>
<thead>
<tr>
<th>Previous crop</th>
<th>Nitrogen rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal or corn (residue)</td>
<td>180</td>
</tr>
<tr>
<td>Cereal or corn (no residue)</td>
<td>140</td>
</tr>
<tr>
<td>Row crop</td>
<td>120</td>
</tr>
<tr>
<td>Beans or peas</td>
<td>80</td>
</tr>
<tr>
<td>Green manure crop</td>
<td>60</td>
</tr>
</tbody>
</table>
There are several pests that require control to attain maximum economic yield of hybrid sweet corn seed crops. These include three important diseases:

1) Common smut caused by *Ustilago maydis*. Incidence increased by excessive N application.

2) Head smut caused by *Sphacelotheca reiliana*. Crop rotation, resistant cultivars, and carboxin seed treatment reduces incidence of head smut.

3) Seedling blight caused by an interaction of *Penicilium oxalicum*, *Fusarium* spp. and *Pythium* spp. Seedling blight is controlled by seed treatments.

An insect pest of corn wherever it is grown, corn earworm needs to be monitored and controlled.

Seed parent rows are detasseled by mechanical means or by hand. There is no male sterility in hybrid sweet corn seed crops.

Harvesting - Ears are harvested at 30 to 50% seed moisture content in SU types and SH-2 types at 40-70% seed moisture. Seed moisture is not the best index. Black layer formation in the seed consistently precedes maximum seed vigor, but does not occur at 30% seed moisture content as in field corn (Wilson and Trawatha, 1991). Early harvest results in seed with high germination, but low seed vigor, an important seed quality characteristic in hybrid sweet corn. Harvest most often takes place at about 45 days after pollination. However, leaving the seed crop 80 to 90 days after silking produced a high vigor seed crop. Ears are mechanically harvested and husked.

Seed drying and conditioning of hybrid sweet corn seed crops involve several important post-harvest operations. The husked ears are dried at 100 to 104°F in boxes or in bins. The first 24 hours of drying should be at less than 90°F, then the temperature of the dryer can be raised. The dried ears are mechanically shelled. Care must be taken in the shelling process. Shelling is the only post-harvest operation that consistently caused reduction in seed quality (Wilson et al., 1994). Seed germination and seed vigor are reduced by shelling-caused injuries. After shelling, the air-screen cleaner is first used, followed by the gravity table and the size grader. Elevators in the seed cleaning plant should be lined with rubber to minimize impact injuries to seed.

8.8 References


