Cucurbit

Seed Production in the Pacific Northwest

Vegetable seed production in the Pacific Northwest is an important agricultural industry. Vegetable seeds are usually produced under contract with specific seed companies. These contracts generally specify acres to be planted, minimum seed quality accepted, seed grading, and pricing.

Vine crops—cucumbers, squashes, pumpkins, muskmelons, watermons, and citrons—belong to the family Cucurbitaceae, commonly known as the gourd family. A number of important genera and species are grown for seed in the Pacific Northwest.

Table 1 gives crossing-group codes (with genus, species, and chromosome numbers) and, under each code, common cultivars or types. To determine whether different cucurbits will intercross, you'll need both the crossing code and the cultivar names.

Isolation

Check with your seed company field representative about isolation requirements for the specific cultivars that you plan to grow. Talk to your neighbors about cultivars they might be growing in adjacent fields (these might pose problems with unwanted crosses).

Figure 1 takes the group codes (A, B, C, etc.) from table 1 and shows the crossing possibilities among the crops they represent. All cultivars within a given species will cross readily if they're visited by bees. Isolation between cultivars of the same species should be at least 1½ miles—preferably, 2 miles or more.

Although researchers tell us that crosses are possible between different species, these crosses are very difficult to make—and the resulting hybrids will most probably be sterile. According to recent research, any crossing that does occur between species in seed production is probably of no importance.

You can plant cultivars of different species close together without fear of contamination. In figure 1, a ¼-mile separation is recommended, to insure against accidental contamination from mixing of fruit and for special situations.

In the past, researchers reported different chromosome numbers for squash, gourds, and pumpkin. However, recent research and observations have shown that these reports were in error—it's clear now that all *Cucurbita* species have 20 pairs of chromosomes. (This is not true of cucumber, muskmelons, and watermelons, which have 7, 12, and 11 pairs, respectively.)

Be sure to check with your field representative about proper isolation distances or staggering your planting dates.

With hybrid varieties, male rows are often not harvested, which reduces yields per acre.

With some contracts for cucurbit seed production, hand labor may be necessary. Vine-training may be necessary to keep male rows from intermixing with female rows. To reduce contamination from self-pollination, you may have to hand-prune female rows after a certain number of fruit have set.

Culture

Cucurbits require good soil, fertilizer, and plenty of water. You'll need enough irrigation to keep the plants in an active and vigorous condition through the middle of the growing season. After fruits are approximately full size, excess water can encourage *Sclerotinia* fungus, which can kill plants and rot fruit.

Pumpkin and winter squash have special needs—don't irrigate them as heavily as you do summer squash. Excess water produces too much vine growth, delays maturity of the fruits, and causes disease—which can complicate harvest and reduce seed yields.

Vine seed crops are characteristically warm-season crops that are intolerant of frost. Cucumber, squash, and muskmelon grow well where average summer temperatures of 65 to 80° F prevail.

Certain cultivars of *Cucurbita moschata* (Butternut), *Cucurbita*

This publication is one of a set on producing vegetable seeds in the Pacific Northwest, prepared cooperatively by Extension specialists in Oregon, Idaho, and Washington. Each publication presents information about taxonomy, isolation, culture, pollination, soil preparation, planting, pest control (diseases, insects, and weeds), and harvesting.

Titles in the set are cucurbits; turnip and rutabaga; spinach; cabbage, Brussels sprouts, cauliflower, and kohlrabi; kale and collard; mustard and Chinese cabbage; table beet and Swiss chard; carrot, parsnip, and parsley; lettuce; radish; and onion and leek. The publications are available from local Extension Service offices in each of the three states.

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Table 1.—Crossing-group codes and common cultivars or types of *Cucurbita, Cucumis,* and *Citrullus* species (pumpkin, squash, gourds, cucumber, muskmelon, watermelon, and citron)[a]

Crossing-group code, genus, species, chromosome number	Pumpkins	Summer squash	Winter squash	Gourds and ornamental squash
Group A	Big Tom	*Green elongated*	*Acorn*	*Gourds*
Cucurbita pepo	Cinderella	Caserta	Ebony	Apple
n=20	Connecticut Field	Cocozelle	Table Ace	Bicolor
	Early Sweet Sugar	Zucchini	Table King	Crown of Thorns
	Funny Face	Veget. Marrows	Table Queen	Miniature
	Halloween	*Yellow elongated*	*Others*	Miniature Bottle
	Howden's Field	Butterbar	Vegetable Spaghetti	Nest Egg
	Jack O'Lantern	Crook Neck	Delicata	Orange
	Jackpot	Eldorado		Pear
	Luxury	Goldbar		Spoon
	Small Sugar	Golden Girl		Warted
	Spirit	Golden Zucchini		
	Spookie	Straight Neck		
	Sugar Pie	*Flat-shaped*		
	Tricky Jack	Green Tint		
	Young's Beauty	Pattie Pan		
	Eat-All	Scallopini		
	Lady Godiva	White Scallop		
	Triple Threat			
	Minijack			
Group B	Cheese		Butternut	
Cucurbita moschata	Dickinson Field		Hercules	
n=20	Golden Cushaw		Hybrid Butternut	
	Kentucky Field		Patriot	
			Ponca	
			Waltham Butternut	
Group C	Big Max		Baby Blue	*Ornamental squash*
Cucurbita maxima	King of the Mammoths		Banana	Alladin
n=20	Mammoth Chile		Boston Marrow	Turk's Turban
	Mammoth Prize		Buttercup	
	Atlantic Giant		Delicious	
			Emerald	
			Gold Nugget	
			Golden Turban	
			Hubbard	
			Hubbard Hybrid R	
			Kindred	
			Marblehead	
			NK 530	
			NK 580	
			Sweet Meat	
			More Gold	
			Blue Hubbard	
			Golden Delicious	
Group D	Green-Striped Cushaw			
Cucurbita mixta	Japanese Pie			
n=20	Tennessee Sweet Potato			
	White Cushaw			
	Mixta Gold			

[a] Adapted from Current Information Series 723 (Moscow, University of Idaho Cooperative Extension Service, 1984).

Table 1 (continued)—Crossing-group codes and common cultivars or types of *Cucurbita, Cucumis,* and *Citrullus* species (pumpkin, squash, gourds, cucumber, muskmelon, watermelon, and citron)[a]

Crossing-group code, genus, species, chromosome number	Cucumbers	Muskmelons	Watermelons	Citrons
Group E *Cucumis sativus* n=7	All pickling cucumbers All slicing cucumbers (except Armenian) Beit Alpha cucumbers Lemon cucumbers			
Group F *Cucumis melo* n=12	Armenian Snake cucumber or Serpent melon	All muskmelons Casabas Honeydew		
Group G *Citrullus lanatus* n=11			All watermelons	All citrons

[a] Adapted from Current Information Series 723 (Moscow, University of Idaho Cooperative Extension Service, 1984).

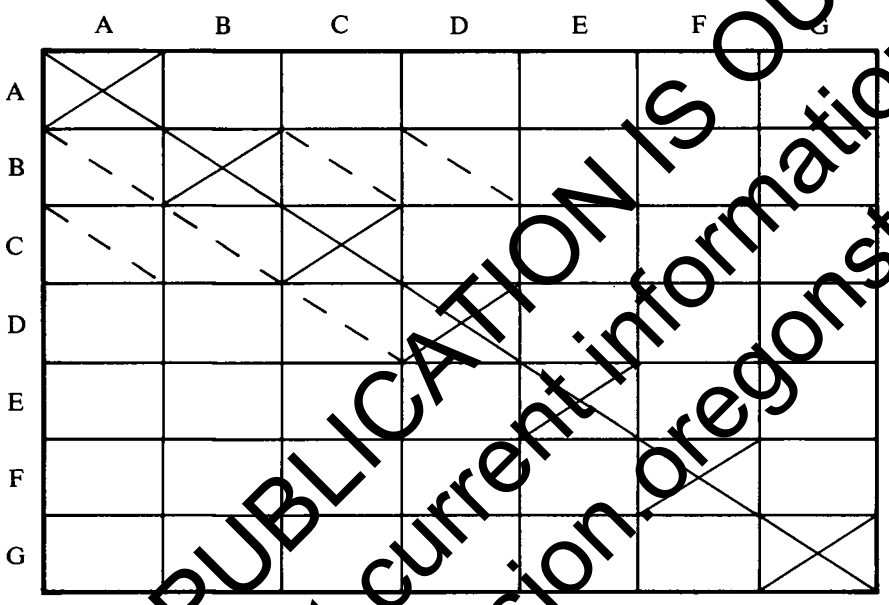

Figure 1.—Crossing possibilities between code groups (see table 1). An × indicates the two groups cross readily; ¼-mile isolation is a minimum—preferably, 1½ to 2 miles. A diagonal broken line indicates that crosses between the two groups have been reported, but they are of little or no significance for contamination in seed production; in these cases, ¼-mile isolation is enough. This chart is developed from data in Whitaker, Thomas W., and Glen N. Davis, *The Cucurbits* (London and New York: Leonard Hill, Interscience Publishers, 1962).

mixta, Cucumis sativus, and *Cirullus lanatus* may mature too late for successful seed production in the valleys of the Pacific Northwest.

The production of vine seed crops is similar to production of the same crops for fresh market or processing. The tendency has been to drill smaller-seeded vine crops like cucumbers and to plant in hills the larger-seeded crops (watermelon, squash, and pumpkin). Good yields have been reported with both methods. The hill method provides an opportunity for early cross-cultivation if weeds are a serious problem.

Pollination

Both open-pollinated and F_1 hybrid cultivars of vine seed crops require honey bees for effective pollination.

Place one or two hives per acre when first flowers begin to appear. With many hybrid cultivars, male blossoms begin to appear several days before female flowers do. When this occurs, delay putting out the bees for a few days after you note the first male flowers. Bees favor vine crops for feeding, so they seldom move to other flowering crops.

Be careful not to injure the bees with insecticides. It's best to stop all insecticide applications when bees are introduced. If you can't wait to apply the insecticides, use pesticides with low toxicity to bees—and be sure to apply them after the bees have returned to the hives in the evening.

If possible, remove hives temporarily from the field or protect them from the insecticides. Notify local beekeepers whenever you plan to use insecticides; they'll help protect the bees.

Soil preparation

Prepare seedbeds to a medium-fine texture. Apply lime, fertilizer, and appropriate herbicides as needed before planting.

Fertilizer

Always base your fertilizer applications on recent soil test information. Apply 300 to 400 pounds of complete fertilizer (10-20-10) per acre at seeding. Sidedress or broadcast your nitrogen (up to a total of 100 or 120 pounds per acre) over several applications during the growing season—provided irrigation is adequate to maintain vigorous growth.

The best pH is 6.0 to 7.0. Add lime as needed.

For preplant fertilizers, these are the recommended application levels (in pounds per acre): N, 30 to 40; P_2O_5, 50 to 150; K_2O, 50 to 150; S, 20 to 30. An additional 50 to 60 pounds of nitrogen may be banded at planting; apply 50 to 60 pounds more when runners begin to form.

With some cultivars, split applications of supplemental nitrogen do not seem to offer any consistent advantage over a single application.

Planting

Plant vine crops in a well-prepared seedbed from May 1 to June 1. May plantings are easier to establish than those made in June. Plants from mid-June plantings may not have a long enough season to mature seed.

Treat all seed with a fungicide before planting, to control damping-off. Damping-off losses are usually most serious on very early plantings, when soil temperatures are low.

If you drill vine crops, space your rows 3 to 10 feet apart, with plants 4 to 12 inches apart in the row, depending on the crop. With hill-planted crops, place the seed in hills 3 to 3½ feet apart. Seedling rates vary from 3 to 4 pounds per acre, depending on the spacing and seed size.

Cucumbers. Of all the vine seed crops, cucumber seed production can be the most complicated, especially when you produce hybrid cultivars. Cucumbers fall into three main types: pickling, slicing, and greenhouse parthenocarpic (rare in the Pacific Northwest).

Be sure that you understand the production details for the specific cultivar you plan to grow before you make a commitment to produce the seed. Obtain this information from your contracting seed company.

Squash. There are two main types, summer or bush squash and winter or vining squash. From a seed-production standpoint, both types are relatively easy to grow, but they differ in their cultural and handling requirements.

Summer squash such as White Scallop, Yellow Crookneck, and Zucchini require better soils, are more responsive to fertilizer, and are generally higher-yielding than winter squash. Plant cultivars of summer squash in rows or hills 3 to 4 feet apart.

Plant cultivars of winter squash such as Table Queen, Butternut, and Buttercup farther apart, 6 to 8 feet between hills. Experiments with the very large Mammoth and Hubbard cultivars indicate that varying the spacings, both between and within rows, has little effect on seed yields. The trend, however, is toward higher seed yields at closer spacings.

Squash and pumpkin. Plant all cultivars of squash and pumpkin between May 1 and June 1. You'll need 3 to 5 pounds of seed per acre, depending on the spacing you use.

Muskmelon and watermelon. High-quality seeds can be produced in those areas favored with a long growing season and with fairly high summer temperatures. Unlike cucumbers, however, they are not adapted to western Pacific Northwest growing conditions.

Watermelons require a long season for maturity and grow well where average temperatures are above 70° F. Watermelons and muskmelons can be grown successfully along the Snake River in eastern Oregon, in the irrigated Hermiston area of Oregon's Umatilla County, in the southern Washington area along the Columbia River, and in sections of Oregon's Douglas and Jackson counties. Other areas of similar climates and soils would also be suitable.

Watermelons need sandy soils. The preferred time to plant is from May 15 to June 10. Spacing between hills varies from 8 to 10 feet.

Pest control

Diseases. Table 2 shows the diseases common to cucurbits. Table 3 lists some vine crop diseases and their host crops. See also the current edition of the *Pacific Northwest Plant Disease Control Handbook* (see "For further reading," page 7).

Insects. The western twelve-spotted cucumber beetle can be a serious pest of cucurbits grown for seed west of the Cascades. The adult

Use pesticides safely!

- **Wear** protective clothing and safety devices as recommended on the label. **Bathe or shower** after each use.
- **Read the pesticide label**—even if you've used the pesticide before. **Follow** closely the instructions on the label (and any other directions you have).
- **Be cautious when you apply pesticides. Know** your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

Table 2.—Diseases common to cucurbits[a]

Disease	Cause	Symptoms	Control measure
Damping-off	Fungus	Seedlings fail to emerge or fall over at ground level shortly after emerging.	Use treated seed. Keep soil moist but not saturated during seed germination and early seedling growth.
Cladosporium root and leafspot	Fungus	Dead tissue produced in patches on leaves or a moldy growth in patches on fruits.	Spray entire plant with appropriate chemical.[b]
Powdery mildew	Fungus	White, thin, powdery growth on leaves. May be seen first on undersides of leaves.	Use resistant cultivars. Spray with appropriate chemical.[b]
Fusarium root rot	Fungus in soil	Unthrifty appearance of plant, followed by wilting. Root system rotted.	Rotate crops. Fumigate soil. Use resistant cultivars.
Fusarium wilt and verticillium wilt	Fungus	Similar in appearance to bacterial wilt.	Rotate crop. Fumigate soil. Use resistant cultivars.
Bacterial wilt	Bacteria	General unthrifty appearance of plant, followed by wilting and death.	Use resistant cultivars. Rotate planting area from year to year.
Curly top	Virus	Yellowing of newer leaves, stunting of growth, small fruit, and poorly formed leaves.	Use resistant cultivars. Control leafhoppers. Destroy diseased plants.
Cucumber mosaic	Virus	Mottling of the leaves and dwarfing of new growth.	Use resistant cultivars. Control aphids. Destroy diseased plants.
Bacterial soft rot	Bacteria	Slimy rot of fruits or other parts of plant.	Keep plant parts dry and prevent splashing soil during watering. Sprays may help.[b]
Storage rots	Many fungi and bacteria	General rotting of fruits in storage.	Store only clean, disease- and damage-free fruits. Keep fruit surfaces dry. Immediately remove any diseased fruits.

[a] Reprinted from Current Information Series 72 (Moscow, University of Idaho Cooperative Extension Service, 1984).
[b] Consult the current edition of the *Pacific Northwest Plant Disease Handbook* (see "For further reading," page 7 in this publication).

Table 3.—Some vine crop diseases and their host crops (S = susceptible; R = resistant; T = the disease will occur but will rarely if ever cause losses)[a]

	Crop				
Disease	Muskmelon	Cucumber	Pumpkin	Squash	Watermelon
Angular leaf rot *Pseudomonas*	S	S	S	S	S
Bacterial wilt *Erwinia*	S	S	S	S	R
Alternaria leaf blight *Alternaria*	S	S	S	S	S
Cucumber mosaic virus (CMV)	S	S	S	S	S
Anthracnose *Colletotrichum*	S	S	R	R	S
Downy mildew *Pseudoperonospora*	S	S	S	S	T
Gummy stem blight (black rot) *Mycosphaerella*	S	S	S	S	S
Scab *Cladosporium*	S	S	S	S	R
Powdery mildew *Erysiphe*	S	S	S	S	T

[a] Reprinted from *Illinois Vegetable Farmers Letter,* August 1980.

beetles feed on the plants from the moment they emerge from the ground, right on through harvest. They feed on flowers and can prevent successful pollination. The larvae feed on roots and tunnel through underground parts of stems.

The adults overwinter in protected areas away from fields—neighboring wood lots, weedy fence rows, and ditchbanks. They are active in late March, feeding on a variety of weed and crop plants. There are two generations a year.

If these beetles are a problem, you can control them with various insecticides that you apply before bloom, and before honey bees are placed in the field for pollination. If you have a problem during bloom, use a registered material in the late evening, after bee activity has stopped.

The seed-corn maggot is a pest of all cucurbit seeds. Maggot-injured seeds either fail to sprout or, if they do, produce weak and shriveled plants. The maggot overwinters in the soil in a dark brown capsule called a *puparium*. The small gray flies emerge in April and are active throughout the summer.

Shallow-planted seed, in warm soil, results in rapid germination and helps to avoid seed-corn maggot injury. Seed treatments or banded insecticides at planting also reduce injury from this pest.

For chemical control methods, see the current edition of the *Pacific Northwest Insect Control Handbook* ("For further reading," page 7).

Weeds. Choose fields free of weeds; weed-control chemicals for cucurbits are only partially effective. If it's practical, use the "stale seedbed" technique: prepare the seedbed 2 to 3 weeks before planting; irrigate the soil; when the weeds emerge, burn them off chemically before you plant. When you do plant, disturb the soil as little as possible.

There are herbicides registered for certain uses on one or more vine crops. For chemical weed control methods, see the current edition of the *Pacific Northwest Weed Control Handbook* ("For further reading," page 7). Check also with your Extension agent, commercial applicators, and seed company field representatives. And follow the instructions on the herbicide label!

Using growth regulators

With some vine seed crops, you'll have to apply certain growth-regulating chemicals—to promote the formation of female flowers or to prevent the development or initiation of male flowers. Ethephon is used to increase female flowering.

On the other hand, when you grow gynoeocious (all-female-flowering) types, you'll probably use a growth regulator to bring about male flower formation—gibberellic acid (usually GA_3 or GA_7) or silver thiosulfate. Three to five applications may be necessary, beginning with the formation of the first true leaf and continuing with an application at the onset of each new leaf.

You'll need to apply growth regulators in a timely manner. You may have to adjust your rates of application for varying air temperatures, to avoid damaging your plants. Use only fresh regulator chemicals—and keep them for only a short time after you mix them. Your seed company representatives should be able to help you quite a bit with specific recommendations for specific cultivars.

Harvesting and threshing

Cucumbers. Your cucumbers are ready for harvest when the seeds are mature—when they're no longer attached to the placenta or flesh and when the fruits turn color. The black-spined cultivars are deep yellow to orange at maturity; the white-spined types are light yellow to almost white.

Special harvesting machines are needed to crush the fruits and to separate the rind and part of the pulp from the seed. In years past, one common method of freeing the seed from the pulpy material was to ferment the wet seed or treat it with acid. However, overfermentation discolors seed and lowers its quality, so some washing systems no longer use fermentation or acid treatment.

After washing, place the clean seed in trays or revolving drums for drying. Warm, forced air speeds drying. If you choose tray drying, be sure to stir the seed occasionally to obtain uniform drying and to prevent the seed from sticking together.

This raking machine is placing winter squash into windrows for later pickup by the harvester (photo courtesy of Arco Seed Co., Brooks, Oregon).

During the first part of the drying process, when the seed is still wet, temperatures should not exceed 100° F. Temperatures throughout the remainder of the drying period should not exceed 110° F.

Cultivars differ in yielding ability. Pickling cucumber cultivars yield more seed than slicing cultivars. Yields of 800 to 1,000 pounds of seed per acre can be obtained with pickling cultivars, but 500- to 600-pound yields are more characteristic of the slicing types.

Squash. Harvest your squash seed after the first frost, when the fruits have taken on their characteristic matured color and when the seeds inside the shell break away readily from the pulp. If the seed is immature, the pulp will adhere to the seed.

Summer squash can be harvested with a cucumber thresher. Where proper threshers are not available, you could split squash open and scoop out the seeds by hand. After you extract summer squash seed, wash it within 48 hours to prevent heating.

Winter squash have thick, tough shells. It isn't quite as critical to handle winter squash seed immediately after threshing as it is for summer squash—but process the seed within 3 or 4 days after you remove it from the fruits. To keep the seed coat white, place the seed on trays or rotary dryers within a day after washing. Drying temperatures are the same as those for cucumbers.

Seed yields vary greatly for both summer and winter squashes, depending on the cultivar. Yields from 600 to 800 pounds of seed per acre are common for summer squash cultivars. Yields from 400 to 500 pounds are typical for winter squash cultivars.

Pumpkins are similar to winter squash in growing requirements and in general threshing and processing procedures. Pumpkin yields range from 600 to 1,000 pounds of seed per acre under irrigated conditions.

Muskmelons. The harvest differs somewhat from that of other vine crops. Muskmelons do not mature uniformly; therefore, you must harvest the ripened fruit several times during the season.

The pulp is sweet, and it deteriorates rapidly—so be careful to avoid excessive fermentation after threshing. Start the washing process just at the moment when the pulpy material begins to break down.

Seed yields of muskmelons in eastern Oregon average 300 pounds per acre; 500 pounds is considered a high yield.

Watermelons. Watermelon seed is mature and ready for harvest a little beyond the eating stage of the melon. Seed yields are similar to those of muskmelons—about 300 pounds per acre.

The thresher commonly used for cucumbers can be adapted to thresh watermelons. Watermelon pulp ferments rapidly; wash the seed soon after threshing. Excessive fermentation results in poor color and a reduction in the value of your seed.

Salvage of fruit

Efforts to recover and blend chopped pumpkin, squash or cucumber fruit into silage (after the seed has been extracted) have not proved successful economically. Attempts have also been made to blend this excessively moist material with grass or wheat straw for silage; so far, however, the resulting product does not appear to justify the problems involved with handling and processing it.

For further reading

To order PNW publications, enclose the amounts indicated and mail your order to either of these addresses:

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Pacific Northwest Insect Control Handbook, a Pacific Northwest Extension publication (latest edition; published annually). Single copy $15.00 plus $2.50 postage.

Pacific Northwest Plant Disease Control Handbook, a Pacific Northwest Extension publication (latest edition; published annually). Single copy $15.00 plus $2.50 postage.

Pacific Northwest Weed Control Handbook, a Pacific Northwest Extension publication (latest edition; published annually). Single copy $15.00 plus $2.50 postage.

Pacific Northwest cooperative Extension bulletins are joint publications of the three Pacific Northwest states—Oregon, Washington, and Idaho. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949 the PNW program has published over 250 titles. Joint writing, editing, and production has prevented duplication of effort, broadened the availability of faculty specialists, and substantially reduced costs for the participating states.

This publication was prepared at Oregon State University by N. M. Mansour, Extension vegetable crops specialist, and James R. Baggett, professor of horticulture.

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