ONION AND LEEK SEED PRODUCTION

M. K. Thornton, S. K. Mohan,
D. O. Wilson, R. G. Beaver,
& W. M. Colt

Onion (*Allium cepa*) and to a lesser degree leek (*Allium porrum*) are important vegetable crops in the Pacific Northwest. Most of the seed for these crops is produced under contract in the irrigated areas of the Snake River Valley of Idaho and Oregon. Smaller acreages are also grown in the Willamette Valley and Madras regions of Oregon and in the Columbia Basin of Washington.

Production practices vary among the growing areas of the Pacific Northwest due to variations in amount of rainfall, seasonal temperatures, and disease incidence. Net returns vary depending upon cost of production and gross returns as influenced by seed yield, quality, purity, and type of contract.

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Onion production methods

Onions are a biennial crop, and most seed is produced from bulbs that are grown from seed planted in the spring and carried over through the winter as small plants in the field. These plants flower the following spring. This is called the seed-to-seed method. Onion seed is also produced from bulbs grown, harvested, and replanted in the fall, or stored and replanted the following spring. This approach, known as the bulb-to-seed method, is more expensive, but offers certain advantages.

Seed-to-seed method

Yield of onion seed produced by the seed-to-seed method is often higher than that from the bulb-to-seed method because most of these fields have a greater number of plants per acre. Production costs are lower because the plants are produced directly from seed and bulbs are not harvested and stored. The higher seed yields and lower costs are the reasons most commercial onion and leek seed is now produced by the seed-to-seed method.

The seed-to-seed method is most successful when careful attention is given to pest control and when pure stock seed and winter hardy varieties are used. Limited roguing may be required to remove off-type plants.

Seed-to-seed onions must be planted early enough so that most of the bulbs will reach ¾ inch in diameter before winter. Bulbs must reach this size in the fall to ensure that the plants produce seed stalks the following spring. Planting between June 15 and July 15 will allow most varieties of onions to achieve the needed size. When onions are seeded during this period, fields need to be irrigated before seeding. Irrigation is also required during the summer months.

Seed is planted ½ to 1 inch deep in rows 22 to 30 inches apart at a rate of 3 to 4 pounds per acre. Higher seeding rates and closer row spacing (18 inches) have resulted in higher seed yields provided irrigation is adequate and diseases, insects, and weeds are controlled.

Bulb-to-seed method

The bulb-to-seed method is preferable to the seed-to-seed method for the maintenance of onion stock seed. Bulb production for seed differs from commercial onion production in that planting rates are higher so that more bulbs are produced per acre.

Often, seed companies contract with growers to produce seed onion bulbs to be used for onion seed production. In other instances, onion seed producers grow and store their own bulbs.

Onion seed bulbs to be planted in the spring should be stored under cool, well-ventilated, and dry conditions. The bulbs should be maintained at 35° to 40°F with a relative humidity near 65 percent. Potato and apple storage facilities are not suitable for onion bulb storage because of their high humidity.

Planting should be done as soon as the soil can be prepared.

Onion seed bulbs planted in the fall should be planted early enough that the bulbs can become well rooted before the ground freezes. Extra protection should be provided by hilling soil over the bulbs before the ground freezes.

The most desirable bulbs are 2 ½ to 3 inches in diameter. Although larger bulb size gives a slight increase in seed yields and an increased number of seed stalks per plant, the increases usually do not justify the extra expense in handling the additional tonnages of bulbs. With medium-sized bulbs, 7,500 to 10,000 pounds of bulbs are required to plant an acre.

Bulbs are planted upright in rows about 3 feet apart with individual bulbs placed shoulder to shoulder within the row so their tops are near the level of the soil surface. If bulbs are planted shallower than this, support must later be provided to the seed stalks by hilling soil around them.

The bulb-to-seed method provides an opportunity to discard off-types and diseased or otherwise undesirable bulbs. Desirable bulbs can be selected at harvest and again at transplanting.

Bulb production for bulb-to-seed crops

Seeding is done in early spring. The usual method is to plant 4 to 6 pounds of seed per acre in single or double rows spaced 22 inches apart on each bed. Seed should be planted ½ to 1 inch deep, depending on soil type.

The harvest of seed bulbs is similar to that of commercial dry onions bulbs. Bulbs should be mature and carefully cured. This is particularly important for bulbs to be stored over winter. As soon as three-fourths of the tops fall over, the bulbs should be lifted and placed in windrows to cure.

Another method is to lift and top the bulbs and then cure them in slatted crates protected from direct sun and rain.

Hybrid onion seed

Onion seed may be either open-pollinated or hybrid. Hybrids generally have replaced open-pollinated varieties because hybrids have greater uniformity, higher yields, and more disease resistance. Since the first onion hybrids were introduced on the market in the 1950s, seed production has shifted toward hybrid lines.

Hybrid onion seed is produced by both bulb-to-seed and seed-to-seed methods. The seed-producing inbred female line is designated as (A) and the pollen-producing male line as (C). A third line, designated the maintainer (B) line, is virtually identical to (A) except that it produces pollen. Pollen from the maintainer line is used to pollinate flowers of the male-sterile (A) line, which otherwise could not produce seed. In this way the male-sterile female line (A) is propagated. To produce hybrid seed, the female line (A) is pollinated by the male line (C). The (A), (B), and (C) lines are usually maintained by the bulb-to-seed method under stringent isolation.

Sometimes a three-way cross is used to produce hybrid seed. In this system a single-cross male-sterile hybrid is used as the female seed parent instead of an inbred female line. The vigorous male-sterile hybrid plants produce higher seed yields.

The ratio of female (A) to male (C) rows varies with different hybrids; usually an 8-to-2 or 10-to-2 arrangement of rows is used. For pollination to be successful, the (A) and (C) lines must flower at nearly the same time. For some hybrids, the two parent lines must be planted at different times to have the flowering dates coincide. The time a given line flowers can be changed by the bulb storage temperature.

For stock seed production, frequent roguing of the female (A) line is important to remove any male-fertile or other off-type plants. This is done early in the morning when newly shedding pollen can be seen. Rogued plants should be pulled out completely, and any emerged flowers should be buried.

Leek production methods

Leeks do not produce bulbs and must therefore be propagated by seed or transplants. Because of the high cost associated with hand transplanting, most leek seed is produced by the seed-to-seed method.

Leeks are generally planted about 1 month earlier than onion seed fields because leek seed germinates slowly, and the plants must produce approximately seven leaves before flower stalk induction can occur during the winter. The following spring, flowering is stimulated by the lengthening of the days.

Leeks usually flower later than onions, which may cause problems with maturity in a short growing season location. As with onions, hybrid leek seed produces more uniform plants than open-pollinated seed.

Isolation

Onion varieties intercross readily, so attention must be given to isolation distances when seed fields are located. Leek varieties also intercross and must be isolated by a suitable distance (table 1).

Table 1. Recommended isolation distances for onion and leek seed production.

Production fields	Isolation distance (miles)
Hybrid onions	
(should be posted as male parent)	
From hybrids of different color	3
From open-pollinated (O.P.) of different color	3
From hybrid or O.P. of same color but different shape (i.e., globe shape vs. flat)	2
From O.P. of same color and shape	2
From hybrid of same color but different type (i.e., globe vs. Spanish)	2
From hybrid of same color, shape, and type (i.e., yellow Spanish)	1
From bunching onions (*Allium fistulosum*), chives, or leek	None
Open-pollinated onions	
From hybrid of different color or shape	3
From O.P. of different color	3
From O.P. of same color but different shape (i.e., yellow globe vs. yellow high globe)	2
From hybrid of same color and shape	2
From O.P. of same color but different type (i.e., yellow Spanish vs. yellow globe)	1 ½
From O.P. of same color, type, and shape (i.e., yellow Spanish)	1
From bunching onions (*Allium fistulosum*), chives, or leek	None
Leeks	
From onion, bunching onion, or chives	None
From another variety of leek	1

Pollination

Onions and leeks are pollinated by insects, particularly honeybees and leafcutter bees. These pollinating insects must be protected during the flowering period by choosing chemical insect control methods and timing that minimize unwanted effects.

When flowering begins, 5 to 10 hives of honeybees per acre should be moved to the edge of the fields. More hives are usually placed around hybrid than open-pollinated onion fields. Hive selection should be based on vigor to ensure a high level of bee activity.

Pollination can be a problem in onion seed production because honeybees are sometimes not attracted to onion flowers and may move to other crops. Nectar may become concentrated and unattractive to bees during hot, dry weather. High temperature can also cause flowers to die and developing seeds to abort. Intermittent misting of onion seed crops by overhead sprinklers increases seed yields when air temperatures are above 100°F.

The male (C) line plants must be removed by mowing or discing as soon as pollination is complete. If these plants are left standing, seed heads from the (A) and (C) lines can lodge and become intertwined, making harvest of the hybrid seed much more difficult.

Culture

Site selection and preparation

Fields to be used for onion or leek seed production should be free of perennial weeds and have no history of severe soilborne disease problems. A field should not be used for seed production more often than once every 4 years.

Onions and leeks will grow in soil types ranging from light sand to heavy clay or peat. Crops grown on soils with a high salt content (electrical conductivity greater than 4 mmhos/cm) will have poor stand and reduced growth. Seed bulbs or transplants should be grown on soils that are highly fertile, well drained, loose, and porous. Seed germination and seedling establishment require a uniform, firm bed, several inches deep.

Fertilization

Onions and leeks will require nitrogen, phosphorus, and potassium fertilization according to needs indicated by soil tests and the previous year's crop. Fertilization of seed-to-seed crops helps ensure that plants reach sufficient size going into the winter to produce seed stalks the following spring.

About 50 pounds of nitrogen should be applied or be available as soil residual at the time of planting. Additional nitrogen should be applied as one or two sidedressings or through the irrigation water.

Potassium should be broadcast and incorporated before planting the seed. Nitrogen and potassium fertilizer applications should be discontinued at flowering because high levels of these nutrients can cause nectar to become unattractive to bees.

In general, seed crops are fertilized similar to commercial crops. Refer to local fertilizer guides for specific recommendations.

Irrigation

Onions and leeks are shallow-rooted crops and require frequent irrigation to maintain soil moisture above 65 percent of field capacity. Irrigation frequency varies with soil type, plant growth stage, and environmental conditions. An onion crop may use 1 ½ to 2 ½ acre-feet of water beyond the initial moisture required for stand establishment. Winter moisture levels will influence total amounts of irrigation water required during the seed production season.

Diseases and insects

In general, onion and leek seed crops are affected by all the diseases and insects that affect commercial crops. The diseases and insects included here can be of particular importance in seed production. Incidence and severity of diseases and

insects will vary from year to year depending on the variety grown and prevailing climatic conditions.

Disease and insect control and prevention are achieved through site selection, cultural practices, and application of pesticides. For specific control recommendations, consult the annually revised *Pacific Northwest Insect Control Handbook* and *Pacific Northwest Plant Disease Control Handbook*, your local Cooperative Extension personnel, or seed or chemical company representative.

Diseases

Scape and umbel blight

(*Botrytis allii Munn.*) — This disease can damage onion and leek seed crops through infections occurring on the seed stalks. Infection just below the umbel can result in flower blast and capsule blight. Infection of the stalks may lead to partial or complete girdling, and the umbel may topple over, resulting in loss of both seed yield and quality. In Europe, infected seed has been shown to increase the incidence of neck rot in the subsequent commercial onion bulb crop.

Downy mildew

(*Peronospora destructor* (Berk.) Casp.) — Downy mildew, a fungal disease, can destroy onion seed crops when the climate is relatively cool and wet. The first evidence of downy mildew is the appearance of chlorotic areas on leaves and seed stalks.

During periods of humid weather, the surfaces of affected areas appear violet due to production of masses of asexual spore sacks (sporangia). Sporangia are spread by wind to adjacent plants where they initiate new infections. The new infection sites are oval with alternating regions of green and yellow tissue.

During dry weather, the mildew lesions usually become necrotic (dry) in their centers, and the disease fungus does not produce spores. Secondary fungi soon invade the mildew lesions and turn them dark.

Dry weather checks the advance of the disease, but with the return of moist conditions, the mildew resumes its spread. The disease is favored by moderate temperatures (optimum 55°F) and periods of rainy weather or heavy dew.

Pink root

(*Pyrenochaeta terrestris* (Hans.) Gorenz, Walker & Larson) — Pink root disease is found wherever onions are grown. The pathogen is a common soil inhabitant and infects the roots of many plant species including corn, small grains, sorghum, grasses, tomatoes, peas, melons, spinach, and carrots.

In onion, the disease causes stunting, reduced vigor, and reduced seed yield. The most obvious symptom is the pink color of the infected roots, which later turn purple, brown, or black.

The roots ultimately may shrivel and die. In a seed-to-seed crop, these symptoms are usually evident in the spring of the seed production year. Pink root often occurs in association with Fusarium basal rot. Leeks are resistant to pink root.

Fusarium basal rot

(*Fusarium oxysporum* (Schlect.) f. sp. *cepae* (Hanz.) Snyd. & Hans.) — The disease occurs in all regions where onions are grown and occasionally results in stand losses and reduced seed yield. Infected plants have a scant root system, and the affected roots are dark brown, flattened, hollow, and transparent. The stem plate shows brown discoloration, pitting, rotting, and shrivelling. The rot may progress upwards into the fleshy scales.

Affected plants show progressive yellowing and die back from the tops of the leaves. They can be easily pulled out of the ground. Although leeks have not been reported to be infected by *F. oxysporum*, yield losses due to *F. roseum* and *F. culmorum* have been reported.

Other diseases

Other diseases that may become serious problems in seed production fields under certain growing conditions include purple blotch (*Alternaria porri* (Ellis) Cif. and *Stemphylium* sp.), white

rot (*Sclerotium cepivorum* Berk.), yellow dwarf (onion yellow dwarf virus transmitted by aphids), and aster yellows (mycoplasma transmitted by leafhoppers).

Insects

Onion thrips

(*Thrips tabaci*) — The most common and perhaps most serious insect in onion and leek production is onion thrips. Severity of infestation varies from year to year, and the exact population necessary for economic damage is not known.

Thrips feed on leaf surfaces, most commonly during dry, warm weather. Their feeding causes the leaves to become white or silver. Thrips are slender, about 1/25 inch (1 millimeter) long. They usually hide in the angles of leaves. On seed crops, they colonize and feed on the flower, which results in poor seed set and light seed.

Control of thrips on the flowering crop is complicated by the need to protect pollinating insects, especially honeybees, when insecticides are used.

Maggots

The onion maggot, *Delia antigua*, occurs primarily in coastal areas, and the seed corn maggot, *Delia platura*, is found both in coastal and interior regions. Both are pests of onion and leek.

Onion maggots may attack plants of any age, but first-generation attack of seedlings is more important. The seed corn maggot confines its attack to germinating seeds and the succulent stems of seedlings. Damage is done by the white, legless larvae. Infestation can cause stunting, yellowing, or death. Damaged onion bulbs often rot in storage.

Weeds

Because onions and leeks are poor competitors against weeds, good weed control is required for optimal production. Weeds interfere with harvesting, and weed seed is a contaminant of both onion and leek seed.

Three categories of weeds cause problems: winter annuals, summer annuals, and perennials. The most troublesome winter annual weeds are London rocket and shepherdspurse, but sowthistle, prickly lettuce, common mallow, annual bluegrass, canarygrass, wild oats, and various mustards also can create problems. Troublesome summer annuals include barnyardgrass, yellow mustard, lambsquarters, marestail, pigweed, nightshade, purslane, kochia, and sunflower.

Perennial weeds such as yellow nutsedge, quackgrass, Canada thistle, and field bindweed, which usually appear in the spring and summer, are the most difficult to control. Nutsedge multiplies rapidly during the season and fouls fields for succeeding crops if not controlled.

Adequate weed control can be achieved only if the entire rotation sequence is designed to minimize weed populations. Perennial weeds and problem annual weeds in rotation crops should be controlled using methods recommended in that crop. A short fallow period before leek or onion seed crops are planted also provides an opportunity to use tillage or nonselective herbicides to control weeds. Soil fumigation can also be considered where losses to diseases or perennial weeds justify application.

Weedy vegetation should be destroyed during seedbed preparation. Nonselective herbicides or flaming can be applied between planting and crop emergence to control early germinating weeds. After emergence, cultivation and selective herbicides are used to suppress weeds.

Cultivation early in the spring will help control winter annuals. Summer annuals are effectively controlled by combinations of cultivation and selective herbicides. A late-spring layby herbicide application suppresses weeds through the harvest

period. Specific weed control recommendations can be found in the annually revised *Pacific Northwest Weed Control Handbook.*

Harvesting, Drying, and Threshing

In southern Idaho and eastern Oregon, onion and leek seed is ready to harvest in late July and August. Seed heads should be gathered when approximately 30 percent of the heads have some opened capsules that expose the black, ripened seeds.

Timely harvesting is necessary because the seed will easily shatter from the head when overmature. Early harvest results in reduced seed weight and lower seed germination. Two or three pickings are required to obtain the largest yield of ripened seed. On a commercial scale it is more practical to harvest all the heads at one time, however.

The heads, with a short piece of stalk attached, are cut by hand and dropped into a burlap sack or bucket supported at the waist of the picker. After picking, the seed heads may be left in burlap bags in the field to dry for 1 to 2 days before they are transported to the drying facility. Care should be taken to keep the heads from heating as this will reduce seed quality.

Mechanical seed harvesters are also used. Machine harvesting may be done a few days earlier than hand harvesting to reduce seed loss from shattering.

Seed heads are normally dried by forced air in boxes or large bins. Small quantities can be successfully sun-dried by spreading the heads on a clean surface in a shallow layer. As soon as the seed heads are sufficiently dry, they can be threshed by an ordinary grain separator, combine, or specially built machine. During mechanical threshing, care should be taken to adjust the equipment to prevent injury to the seed.

A magnifying glass is generally used to examine the seed for cracks and chips. Breakage of the "button" (receptacle of the individual flowers) should be avoided because this material has the same density as the seed and small fragments cannot be easily separated from seed. Seed that shatters during drying can be mixed directly with the threshed seed.

Seed Yields

Seed yields vary from year to year. Yields from the bulb-to-seed method range from about 300 to 500 pounds per acre, though yields above 1,000 pounds per acre have been reported. Yields from the seed-to-seed methods range from about 500 to 700 pounds per acre for open-pollinated lines, and from 300 to 1,000 pounds per acre for hybrid lines.

The authors *— Michael K. Thornton, Extension potato and onion specialist; S. Krishna Mohan, Extension plant pathologist; Dale O. Wilson, seed physiologist; R. Gary Beaver, President SIARCO, Parma, Idaho, and former Extension potato and onion specialist; Wm. Michael Colt, Extension horticulturist; Department of Plant, Soil, and Entomological Sciences, Parma Research and Extension Center, University of Idaho.*

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