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Guide

Suggested Cultural Practices for Onion

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Introduction

Onion (*Allium cepa*) is a popular vegetable grown for its pungent bulbs and flavorful leaves. It is widely grown throughout the world.

The Onion Plant

The bulb is composed of concentric, fleshy, enlarged leaf bases or scales. The outer leaf bases lose moisture and become scaly and the inner leaves generally thicken as bulbs develop.

The green leaves above the bulb are hollow and arise sequentially from the meristem at the innermost point at the base of the bulb. The stem is very small and insignificant during vegetative growth.

The onion root system is fibrous, spreading just beneath the soil surface to a distance of 30 to 46 cm. There are few laterals, and total root growth is sparse and not especially aggressive. Therefore, in monoculture, onions tolerate crowding, particularly in loose, friable soils such as peat and muck.

Cultivars differ substantially with respect to the threshold daylength required for bulbing. Other factors such as temperature may interact with daylength to modify the bulbing response. In all cultivars, bulbing is accelerated with increasing temperature.

Temperature extremes not only affect the rate of bulbing, but also affect the bulb shape. Thick and elongated necks are common in plants exposed to 6° C. or lower.

Cultivars

At one time, all onion cultivars were open-pollinated, and many of these cultivars are still offered by seed companies. The discovery of male sterility in onion led to a rapid change to F_1 hybrids, possibly due to simplicity and low cost of seed production. Hybrids have higher yield, larger and more uniform bulb sizes compared to open-pollinated cultivars.

The bulb onion cultivars are grouped into short, intermediate, and long-day types (Table 1). Short-day onions (12 to 13 hour threshold) are generally mild, soft fleshed, and suitable for storage. These include Bermuda and Granex types.

The intermediate-day cultivars (13.5 to 14.5-hour threshold), are relatively soft-fleshed and used primarily for fresh trade. They are grown in areas of mild temperatures lying between 32 and 38° latitudes.

Long-day cultivars (over 14.5-hour threshold) include yellow, white and red globes. When grown in the lower latitudes, long-day cultivars will not receive sufficient daylength to form bulbs and only green onions would be produced.

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Table 1. Types of onion cultivars (open-pollinated cultivars are underlined)

Daylength	Color	Pungency	Representative cultivars
SHORT	Brown	Sweet	*Awahia*
	Red	Sweet	*Red Granex*
	Red	Pungent	*Red Creole*
	White	Sweet	*White Granex, Crystal Wax*
	Yellow	Sweet	*Grano, Granex*
	Yellow	Pungent	*Yellow Creole*
INTERM.	Brown	Moderate	*Cochise Brown*
	Red	Moderate	*Stockton Early Red*
	White	Moderate	*Fresno White*
	Yellow	Moderate	*Rialto*
LONG	Brown	Pungent	*Australian Brown*
	Red	Pungent	*Carmen, Southport Red Globe*
	White	Pungent	*White Lisbon, Ivory*
	Yellow	Sweet	*Fiesta, Sweet Spanish*
	Yellow	Pungent	*Autumn Spice, Downing Y. Globe*

True pearl onions are classified as *Allium ampeloprasum* because they form just one storage leaf. In practice, short-day onion cultivars (*Grano*, *Crystal Wax* and others) when grown in northern latitudes, will develop pearl-size bulbs and be marketed as such. Most are used in pickling or in frozen mixtures of peas, broccoli and other vegetables.

Green onions, scallions, multiplier, and bunching onions are all used in the immature stage. Green onions generally are white-fleshed bulbing cultivars of *A. cepa* that are harvested at the miniature bulb stage. Scallions are white cultivars of *A. cepa* that do not form bulbs. Multiplier onions are cultivars of *A. cepa* of Group Aggregatum with white flesh and yellow or brown scales. These are distinguishable from the shallot by the latter's red scales and more delicate flavor. The shallot can be used both in the immature stage and as a dry bulb.

A cross of shallot with pink root-resistant *A. fistulosum* gave rise to the tetraploid cultivar *Beltsville Bunching*. *A. fistulosum* includes the bunching onions, also called Japanese bunching onions or Welsh onions.

Environment and Cultural Practices

Soils and climate

Onions can be grown successfully on any fertile, well-drained, non-crusting soil. The optimum pH range, regardless of soil type, is 6.0 to 6.8, although alkaline soils are also suitable. Onions do not thrive in soils below pH 6.0 because of trace element deficiencies, or occasionally, aluminum or manganese toxicity.

Onion is a cool-season biennial, and is tolerant of frost. Optimum temperatures for plant development are between 13 and 24°C, although the range for seedling growth is narrow, 20-25°C. High temperatures favor bulbing and curing.

Planting systems

Three systems of planting may be employed:

1. *Direct seedling* is preferred and gives excellent results where the season is sufficiently long to provide early prebulbing growth.

2. *Transplants* normally have three to five well-formed leaves at transplant time. Transplant leaves are pruned during growth prior to field setting, thereby facilitating handling and increasing plant hardiness.

3. *Sets* are used in some areas to ensure large bulb size and uniform maturity. Sets are small dry bulbs, approximately 12 mm in diameter, produced the previous season by seeding thickly or growing under conditions favoring rapid bulbing.

Any of the above systems may be used for early green onion production.

Field preparation

Prior to planting, soils should be plowed and disked sufficiently to eliminate debris and soil clods. In most commercial areas, beds 0.9 to 1.0 m wide are formed, and two to six rows are seeded or planted on the bed. If two rows, they may be two-line (twin) rows with plants staggered to achieve proper spacing and high population density.

Sowing

The ultimate yield of onion is determined by the number of leaves that are formed prior to bulbing. Since bulbing in each cultivar is triggered by a specific daylength, early planting is the most effective method of improving bulb size and is a primary factor contributing toward yield. If, however, early planting coincides with cool air temperature or cool wet soils, the stand and ultimately the maturity of the crop will be erratic. Some cultivars of the Bermuda type also may bolt if substantial growth precedes exposure to cool temperature.

Seeds are sown 6 to 18 mm deep in heavy mineral soils, deeper in light mineral soils and mucks. Excessively thick seedlings of bulb onions may delay maturity, however necks tend to be thinner than in sparse seedlings, and bulbs are somewhat more globular in shape.

Using coated seed and precision seeding, the seeding rate can be adjusted easily for projected bulb size. For normal storage onions, seeds are spaced 7.5 cm apart. When smaller onions (for use in pickling or boiling) are desired, spacing would be reduced to 2.5 cm in the row. Larger bulb size is promoted by spacings of 10 cm or more.

Nutrient management

Onion responds very well to organic manure. Organic manure at 25 to 40 t/ha is recommended to obtain high bulb yield.

Onion plants utilize substantial amounts of nutrients. Based on a yield of 18 t/ha of bulbs, the plants remove an average of 66, 11, and 70 kg of N, P, and K respectively.

Soils differ widely in fertilizer needs, depending on production history, soil type, and analysis. Mineral soils, on average, contain 90 to 112 kg/ha of N and 56 to 168 kg/ha of P_2O_5 and K_2O. Therefore, an N, P, and K application of about 160, 90, and 40 kg/ha, respectively, is recommended for onion production on mineral soils (Table 2).

Fertilizer is applied either as a broadcast treatment, or more commonly, as a band 5 to 10 cm directly below the seed set or transplant. One or two side dressings of nitrogen are applied during a season. These side dressings may be applied through the irrigation system.

Fall seeded onions require only P_2O_5 only before seeding and require N when active growth starts in the spring and twice thereafter. Insufficient N will induce early maturity and reduce bulb size; high N may increase bulb size and cause large necks and soft bulbs with poor storage quality.

If heavy fertilization rates are indicated by soil tests, the material should be incorporated throughout the plow layer, or if banded, placed 15 cm to the side of the row.

Minor element deficiencies, particularly zinc and copper, may be encountered. Suggested corrective rates are 11 kg/ha of zinc or 17 to 28 kg/ha of copper, applied every two to three years. Relatively high levels of sulfur are utilized by onions, but corrective applications vary widely, according to soils, leaching losses, and presence of sulfur contaminants in the atmosphere. If applied, sulfur will acidify the soil, and therefore, liming rates should be adjusted accordingly.

Similar fertilizer ratios are recommended for green onions; however, due to short growing period, the application rates would be reduced.

Table 2. General recommendations for compost (t/ha) and inorganic fertilizers (kg/ha) for growing onions on mineral soils.

Fertilizer	Basal	Side-dress	Side-dress	TOTAL
Compost	25-40t			25-40t
N	80	40	40	160
P_2O_5	90			90
K_2O	40			40

Water management

Onions require uniform moisture throughout the growing season. Fields that suffer growth retardation may produce excessive numbers of doubles or splits, reducing the number of Grade 1 bulbs. Furrow irrigation is generally used. Light sandy soils are irrigated with overhead systems or by subsurface seep irrigation where the soil profile allows. Onions at the bulbing stage utilize substantial amounts of water, although excessive moisture must be avoided during the growing season.

Weed control

Onions are weak-rooted and aggressive weeds can severely reduce yields. Cultivation, if used, must be shallow to avoid root damage, and growers usually favor chemical control. Pre-emergent broadcast applications of DCPA or one of several other chemical herbicides have been used with some success.

Management of Disorders

Diseases

Both field and storage diseases reduce profitability. Field diseases include purple blotch, Stemphylium blight, anthracnose, downy mildew, Botrytis leaf blight, pink root, smut, smudge, and several basal rots. Storage diseases include some of the common field rots, black mold, botrytis neck rot, and bacterial soft rot.

Purple blotch

Purple blotch (*Alternaria porri*) attacks onion, garlic, shallot and other Allium crops. Initially, small white sunken spots develop on the leaves. These enlarge, become zonate and under moist conditions, turn purple. These are also prominent on the inflorescence stalks. Infection can cause a semi-watery rot on necks of bulbs that turns yellow-red in color. Infected bulb tissues eventually become papery. This pathogen is widespread and optimum temperature for development is 21 to 30°C. Therefore, it is most serious in hot, humid climates.

The fungus is seed-borne, but the relevance of this phase in initiating disease outbreaks in hot climates is not well documented. Infected onion debris has been implicated as an infection source.

Host-plant resistance is yet to be exploited. Some cultivars appear to be less susceptible, e.g. *Red Creole*. *Taliana Red* in Hungary is reported to be resistant.

Cultural control methods include long rotations with unrelated crops and good drainage. Lowering the density of transplanted crops will reduce infection, as will the application of high rates of calcium superphosphate and potassium fertilizer. Nitrogen fertilizer at low and high rates will increase the prevalence of disease. Routine (weekly interval) field sprays with dithiocarbamate fungicides, particularly mancozeb and chlorothalonil have been reported to be effective.

Stemphylium leaf blight

This disease is caused by *Stemphylium vesicarium*, and has been reported from Europe, Africa, North and South America, and Asia. Foliage losses of 80 to 90 percent have been reported. Disease symptoms are very similar to purple blotch. Lesions are light yellow to brown, watersoaked and progress from the tip to the base of leaves. The conidia have up to six transverse septa, besides several vertical septa. Wet and warm conditions favor the disease spread. Control measures are similar to purple blotch.

Anthracnose

Anthracnose, also called Colletotrichum blight, is caused by *Colletotrichum gloeosporioides*. The disease favors hot (24 to 29°C) and wet conditions. The disease overwinters in sets and soil. Spores are spread by wind, splashing water, and tools. The leaves become twisted due to infection.

Downy mildew

Downy mildew (*Peronospora destructor*) also attacks young plants, appearing as white specks, usually confined to the oldest leaves of young plants. A white mold develops rapidly in cool damp weather and progresses down the sheath, and plants eventually fall over and dry up. The fungus overwinters in bulbs and sets and on plant debris. Spores are carried long distances by air currents. For control, young plants can be treated with mancozeb at weekly intervals until bulbing begins.

Botrytis leaf blight

Leaf blight, commonly termed blast, is caused by several Botrytis species. The disease first appears as white specks on leaves, expanding to cause a dieback from the leaf tips. Tops may be killed completely within a week, and entire fields may be affected. Frequently, blight follows previous damage from insects, disease, mechanical damage, or air pollution. Control is achieved through mancozeb sprays at approximately 7-day intervals.

Bulb rots

Several rots may occur either in the field or in storage. Basal rot, caused by Fusarium species, results in a breakdown of inner scales. Outwardly, the bulb may appear normal. It eventually becomes

soft, however, and will develop a watery rot under moist conditions or a dry shriveled bulb in a dry environment. The disease is most severe in warm areas with poor soil drainage. Botrytis neck rot is an extension of the leaf blight disease and can become serious in storage.

Insects

Thrips

Thrips (*Thrips tabaci*) are tiny insects that cut or "rasp" the epidermis of leaves or stems and suck the plant sap resulting in white blotches on leaves. Severe infestations result in leaf blasting and collapse. Bulbs become distorted and undersized. Infestations are more severe in dry seasons than in moist, and entire fields may be destroyed. The insect has many host plants. Adults and nymphs overwinter on plants or plant debris, or in weeds bordering the field. Most of the insects are female, which can reproduce without a male. Eggs are thrust into the leaves and will hatch in 5 to 10 days.

Diazinon sprays at 7-10 day intervals are recommended to control thrips. Up to six applications may be necessary and good coverage is essential.

Bolting

After vernalization at temperatures below 10°C, the stem elongates rapidly, eventually producing compound umbels. Bolting has been reported to be related to the length of day. However, long days do not induce reproductive growth but tend to accelerate development of the seedstalk once it has been initiated by vernalization. Temperature has a major role in inducing bolting.

Harvest and Postharvest

Harvesting

Onions are ready for harvest when the leaves collapse. For storage, onion tops should have broken over before harvest and the necks should collapse and dry. Storage bulb maturity can be accelerated by withholding irrigation water or by pruning the root system. Bulbs for storage may be harvested when 50 percent of more of the tops have broken over, but the bulbs must be cured and dried thoroughly before being placed in storage. Bulbs intended for immediate use can be undercut when 15 to 25 percent of the tops are down.

To harvest, first a knife or lifter is drawn under a bed or row, cutting roots and loosening the soil. Then the bulbs may be dug or allowed to cure further before digging. Under dry conditions, bulbs may be left to cure in the field, either in place or in windrows. To avoid damage from direct sunlight, however, onions normally are placed in field containers and moved to a dry shady location for subsequent curing.

Curing

The purpose of a curing period is to allow natural dormancy to develop and to dry the onion sufficiently. A properly cured onion will have a dry shrunken neck and dry outer scales. The respiration rate of a cured bulb is lower than that of an uncured bulb. Fully mature bulbs are harvested and cured by exposure to temperatures up to 35° in low (less than 50 percent) relative humidity. Air movement must be provided at the rate of 1 cubic foot/minute/cubic foot of onions (60 cubic meters/hour/cubic meters of onions). Immature onions require twice the rate of air exchange.

Following curing, the temperature of stored onions is lowered gradually to 0 °C, or slightly higher, with the relative humidity at 60 to 70 percent. Air exchange in the storage facility is important to prevent any condensation on the bulbs. Also, when the bulbs are removed from the storage, they should be conditioned for several days at 20 to 50 percent relative humidity.

The tops and roots are removed during harvest. When this is not possible, they should be removed after curing, before storage or sale.

Storage

Freshly harvested onions are dormant and will not sprout for a variable period of time (depending on cultivar). Storage will prolong this dormancy. Sprouting will increase in storage temperatures above 4.4 °C, decreasing again as temperatures exceed 25 °C. To reduce the frequency of sprouting after the rest period, onions may be field treated with maleic hydrazide (MH-30) at 2.2 to 3.4 kg/ha when the tops are still green but beginning to senesce.

Cultivars intended for long-term storage should be firm with a thick dry neck; free from greening, root growth, sunburn, or freeze damage; and well cov-

ered with dry scales. Bulbs with fleshy, soft necks are susceptible to persistent rot, especially if storage humidity exceeds 70 percent.

Flavor in onion is associated with pungency (propyl disulfides and other disulfides) and with sugars (glucose, fructose, and sucrose). Both sugar content and pungency are related to percentage dry matter. Short-day and long-day types differ in their flavors. Pungency and dry matter content are important quality attributes in onions for processing.

Marketing

Onions normally are shipped in 22.7-kg mesh bags. The bulbs are graded by size, with jumbo and pearl sizes frequently used by processors. Those intended for international trade are packed in 25-kg bags.

Green onions are pulled before bulbing, when the basal diameter exceeds 6 mm, and the roots are trimmed near the base. They should be washed free of soil. Discolored stalks are discarded. The green onions are bunched and packed in ice to preserve crisp texture and quality. Vacuum cooling is possible but requires prewrapping in ventilated polyethylene bags to retard wilting. Storage life of green onions is limited to approximately one week at 0°C and 90 to 95 percent relative humidity.

Shallots are harvested by hand when the bases are at least 6 mm in diameter. The outer leaf is stripped off and the roots are trimmed before washing and bunching. If grown for dry bulbs, they are handled in a similar manner as onion bulbs. ⌘