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Onion Culture in Ohio

Fig. 1.—Onions should be cured in windrows so that the bulbs are protected from sunscald. (See page 14.)

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Onion Culture in Ohio

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Onions require and respond to many special environments and intensive cultural practices. The 6000 to 8000 acres of the commercially important, late onion crop in Ohio is grown almost entirely from seed planted on the rather limited muck soils scattered throughout the northern part of the state. A late crop is also grown from seed by many market gardeners on heavily fertilized and in many instances irrigated silt, clay, and sandy loam soils. If, however, a good crop is to be secured on less fertile soils, it is essential that sets be used, as thousands of city, suburban, and farm gardeners are well aware. Even sets require special treatments before and after planting in order to secure the desired crops. Furthermore, different kinds of sets are suitable only for specific purposes. Seedlings are also being used more than in former years.

Growing the Late Crop

The acreage, yield, production, and value of onions for shipment in Ohio and other important onion producing states is shown in Table I, page 4. No estimate is available for the value of onions grown by market, farm, suburban, and city gardeners, although it is likely that their total value is nearly as great as that of the onions used for shipment. Some interesting information is presented in the table. The onion yields for Ohio are lower than for any other state where late crop onions are important. This low yield has been especially pronounced during the past three years. Although this reduction in yield may have been brought about in part by unfavorable climatic conditions such as floods, drouths, winds, untimely frosts, and excessively hot weather, it is more likely that improper cultural practices, including the neglect of proper rotations, were, in part, responsible for the low yields obtained during this period.

Ohio onion producing areas are very fortunately located near large centers of consumption. In addition transportation facilities by rail, road, or boat are especially well provided, so that onions and other vegetables grown extensively on the scattered muck areas of the state can be placed on all the principal markets of the country within a few hours.

Unfortunately, however, certain of these areas have been cropped year after year with onions so that the yields have gradually been reduced, due no doubt to a number of factors, including the depletion of certain mineral nutrients, to the accumulation of disease and insect pests, and perhaps to the production of undesirable soil reactions and compounds. In Hardin county, for example, over one-fourth of the 16,000 acres of muck lands are planted to onions each year. In many instances two or more crops are grown on the same ground on successive years. Rotations must be given more attention if the future of onion culture in Ohio is to be assured.

It is also interesting to note from Table I that the prices paid for early and intermediate onions are considerably higher than those paid for late crop onions. This is especially true for the period from 1924 to 1927 inclusive, but not true for 1928 and 1929. Most of these early and intermediate crop onions are produced by the seedling and set methods of production. Although both methods are slightly more costly than the usual method of growing bulbs from spring sown seed, it might be well for Ohio growers to study the possibilities of at least lengthening their production period by planting some sets and perhaps even seedlings.

Advantages of Muck Soil

Muck soils are so loose and friable that it is possible for each individual seedling to push up through the surface of the soil. On heavier types of soil it is often necessary to plant several seeds close together so that the combined force provided by the germinating seedlings will be sufficient to break the crust which usually forms on these soils. It is, therefore, possible to use less seed on muck soils and at the same time avoid much unnecessary thinning, which is one of the most expensive practices connected with onion growing. In muck soils, moreover, the young seedlings can crowd each other about in the loose soil so that misshapen bulbs need not result as would be the case in heavier types of soil.

Though it is very essential for high yields to have good stands it is equally true that excessive crowding even on muck soils will result in small bulbs which have a low market value. Many growers secure more per acre for their onions than their competitors because their onions grade a higher percentage of U. S. Grade No. 1. This is often true in spite of the fact that their competitors secure larger yields per acre.

Muck soils, due to their high organic matter content, are able to retain a large quantity of moisture, a very essential factor in onion production. Muck soils, moreover, can be worked when quite wet without injury and this is a distinct advantage as cultivations and especially weeding operations must be punctual and timely if onion crops are to be grown profitably.

Ohio muck soils are, in addition to being located near large markets, situated in a very favorable climate. They are far enough north for an ideal development of the cool season onion crop, and far enough south so that a part of their huge store of nitrogen will be liberated each year through the activity of microörganisms which develop best when the soil becomes warm. Adequate drainage is also essential for the best growth of these microörganisms.

Drainage and Irrigation

Onions turn yellow and die on poorly drained soils. This may be due in part to lack of nitrogen as already indicated, or to the death of roots which have been deprived of oxygen from the air which is excluded by excessive water. It is also difficult properly to mature and cure onions on poorly drained soil.

Excessively dry soils, on the other hand, are unsuitable for onion culture. Seeds fail to germinate properly in such soils, plants become stunted,

TABLE 1.—ACREAGE, YIELD, PRODUCTION, AND VALUE OF ONIONS FOR SHIPMENT IN THE PRINCIPAL ONION PRODUCING STATES 1924-1930*

STATE	ACREAGE (ACRES)							YIELD PER ACRE (BUSHELS)						
	1924	1925	1926	1927	1928	1929	1930	1924	1925	1926	1927	1928	1929	1930
TEXAS (early crop)	10,230	9,580	12,510	11,220	18,280	19,700	16,310	202	230	204	196	194	191	196
CALIFORNIA (early crop)	1,540	1,550	2,850	3,950	3,950	3,450	2,000	339	315	325	283	248	252	322
CALIFORNIA (late crop)	4,650	5,850	7,260	5,170	5,160	5,750	6,450	275	300	286	362	297	276	289
NEW YORK (late)	7,750	8,910	7,580	8,530	5,830	7,810	8,000	420	385	360	393	220	458	456
INDIANA (late)	8,350	8,100	8,440	8,100	8,510	8,400	9,400	250	285	323	338	240	290	361
OHIO (late)	6,240	3,460	5,300	7,000	6,550	7,860	6,770	350	298	258	336	136	272	291
MASSACHUSETTS (late)	3,190	3,920	4,420	4,550	3,500	2,730	2,530	390	391	395	295	240	385	420
MICHIGAN (late)	2,970	2,680	3,370	3,200	4,520	5,000	6,700	368	266	381	425	275	356	400
IOWA (intermediate)	750	740	780	800	1,000	1,000	1,020	364	423	315	257	288	375	
IOWA (late)	1,100	1,400	1,600	1,470	1,280	1,420	1,510	380	397	300	272	329	330	300
NEW JERSEY (intermediate)	2,400	2,400	2,900	2,900	3,000	2,550	2,900	272	180	200	240	260	255	

TABLE 1. (CONTINUED)—ACREAGE, YIELD, PRODUCTION, AND VALUE OF ONIONS FOR SHIPMENT IN THE PRINCIPAL ONION PRODUCING STATES—1924-1930*

STATE	PRODUCTION (BUSHELS)—(000 OMITTED)							PRICE PER BU. PAID TO GROWERS ($)						VALUE (DOLLARS)—(000 OMITTED)					
	1924	1925	1926	1927	1928	1929	1930	1924	1925	1926	1927	1928	1929	1924	1925	1926	1927	1928	1929
TEXAS (early)	2,066	2,203	2,552	2,199	3,546	3,763	3,192	1.32	1.40	1.36	1.69	1.10	1.02	2,727	3,084	3,471	3,716	3,901	3,838
CALIFORNIA (early)	522	488	926	1,118	980	869	644	92	1 74	1.39	1 80	.77	1 25	480	849	1,287	2,012	755	1,086
CALIFORNIA (late)	1,279	1,755	2,076	1,872	1,533	1,587	1,864	.78	1.16	.65	.70	1.28	.85	998	2,036	1,349	1,310	1,962	1,349
NEW YORK (late)	3,255	3,430	2,729	3,352	1,282	3,577	3,648	.79	.97	.67	.59	1.35	.75	2,571	3,327	1,828	1,978	1,732	2,683
INDIANA (late)	2,088	2,308	2,726	2,738	2,042	2,436	3,393	.64	.98	.56	.59	1.60	.56	1,336	2,262	1,527	1,615	3,267	1,364
OHIO (late)	2,184	1,031	1,367	2,352	891	2,138	1,970	67	1.06	.65	60	1.60	.55	1,463	1,093	889	1,411	1,426	1,176
MASSACHUSETTS (late)	1,244	1,533	1,746	1,342	840	1,051	1,063	89	1.08	.62	.74	1.01	.85	1,107	1,656	1,083	993	848	893
MICHIGAN (late)	1,093	713	1,284	1,360	1,243	1,780	2,680	.60	.86	.63	.54	1.40	.62	656	613	809	734	1,740	1,104
IOWA (intermediate)	273	313	246	206	288	375		1 24	2 36	.94	1 35	.88	.86	339	739	231	278	253	322
IOWA (late)	418	556	480	400	421	469	453	81	.99	.46	.67	1.15	.60	339	550	221	268	484	281
NEW JERSEY (intermediate)	656	432	580	696	780	650		1.53	1.70	1.00	1.25	1.00	1.35	999	734	580	870	780	878

* Figures from crops and markets reports; 1930 figures are forecasts.

and muck soils are more apt to blow from place to place and thus cause much damage to the growing crop.

On muck soils the same system should be made to serve the dual purpose of drainage and irrigation. The water level should be regulated to a depth of from two to three feet below the surface of the muck. When tile is used, this can be accomplished by allowing the tile drainage water to empty into manholes which are in turn drained from lower levels by larger tile lines. When drainage is essential these large lines are left open, but when irrigation is needed these large tile lines are partially closed, thus forcing the water to rise in the manholes and to back up into the smaller drain tiles. It is essential for

Fig. 2.—Water flows from a stream into this tile line which extends across a field of muck. By obstructing the flow in conveniently arranged manholes the water level is raised so that water backs up into smaller drainage tile lines, thus changing the drainage system into a subirrigation system.

this type of subirrigation that the drain tiles have a very gradual slope. A slope of one to two inches per hundred feet of line is considered best. Laterals are usually spaced from 100 to 300 feet apart. Tile lines should be laid on V-shaped boards in muck to keep them in alignment.

If the muck is drained by ditches, the water level in these ditches can be raised by means of temporary sod dams when the need for water becomes apparent. Many muck areas are located near streams of water which can be diverted into these combination drainage systems (see Fig. 2). In years of extreme drouth, such as the 1930 season, such conveniences are very valuable.

The combination system cannot as a rule be used on sandy, silt, and clay loam soils unless they are underlaid with a semi-impervious subsoil. It is, however, essential that these soils be well drained for onion culture.

Lime Requirements

Onions grow best on a slightly acid or neutral soil. Soil acidity is commonly measured in terms of *p*H (hydrogen ion concentration). A *p*H of 7 indicates a neutral soil; values above 7 indicate alkaline soils; values below *p*H 7 indicate acid soils. As a rule, soil reactions of from *p*H 6 to *p*H 7.5 are favorable for the growth of onions. Reactions .5 of a *p*H below or above these values may not be injurious on soils containing a high percentage of organic matter. A soil with a *p*H reaction of 5 is ten times as acid as a soil having a *p*H value of 6.

Injury on soils with decided acid or alkaline reactions may be due to the presence of injurious compounds such as aluminum or soluble salts, to the lack of adequate soil fertility, to unavailable mineral nutrients resulting from excess acidity or alkalinity, or in rare instances to the toxic effects of the elements which are responsible for acid or alkaline reactions. Injury from soluble salts is commonly although not always associated with alkaline soils. Decidedly acid soils frequently lack sufficient phosphorus for maximum growth.

Many simple tests are available for making soil acidity determinations. If proprietary preparations are purchased directions are included for their use. Recommendations are also included which designate the amount of lime needed, if any, to correct acidity.

Your county agent or the Department of Soils at Ohio State University is always glad to make soil acidity tests as well as a test for the need for phosphorus. The presence of golden yellow onion tips often indicates the need of lime. Muck soils which have been burned or those lying above marl are usually alkaline and often contain an excess of soluble salts. These salts accumulate at the surface as a whitish to yellowish crust during dry seasons. They sometimes cause stunted and unhealthy growths. Soluble salts can be gradually washed away if the soil is well drained.

Lime, where needed, should be applied during the fall so it will have time to become thoroughly mixed with the soil. Some benefits may, however, be secured from spring applications.

Fertilizers

The cost of producing the intensively cultivated crop of onions is unusually great. Although it is important that no more than necessary be spent for fertilizers, it is equally important to apply sufficient fertilizer materials to avoid having the yields limited by lack of food and thus vitiating the usefulness of the other costly and intensive practices.

Potassium.—A 600-bushel onion crop removes approximately 72 pounds of potassium, 21 pounds of phosphorus, and 92 pounds of nitrogen. It is, therefore, apparent that potash fertilizers are very essential. This is especially true for muck soils, as they almost always contain inadequate amounts of potassium. Fertilizers containing large amounts of potash are, therefore, very important for onions grown on muck. Applications of from 200 to 400 pounds per acre of muriate or sulfate of potash or their equivalents are usually necessary.

Heavy applications of potash, especially when applied alone (i.e. without phosphorus) tend to delay maturity. Muriate of potash is equal to, if not better than the sulfate, and since the former is the cheaper it is more generally used.

Nitrogen.—Nitrogen is frequently a limiting factor in onion production even on muck soils that usually contain 1 to 3 per cent of nitrogen, which is three to five times as much as manure contains. This is due to the fact that the nitrogen in muck is in unavailable organic combinations. This nitrogen is made available through the growth of microörganisms which do not grow rapidly during the cooler part of the spring when growing conditions are otherwise ideal for the growth of onions. Nitrogen fertilizers should, therefore, be applied early in the season. Late applications may not only be of no value but may actually delay the maturity of the crop or prevent its proper ripening. Only quickly available compounds should be used. Sulfate of ammonia should be used on alkaline soils, and sodium or calcium nitrate on acid soils. Dried blood and tankage should not be used. Nitrogen applications are seldom beneficial for late planted onions.

The activity of nitrate forming bacteria can be increased by adequate soil drainage, by the correction of excess soil acidity, and by loosening the soil to provide better aeration. The application of well rotted manure, or peat used for bedding stock adds many of these microörganisms which help to render the nitrogen available.

Onions growing on muck rarely respond to applications of more than 300 pounds per acre of 16 to 25 per cent nitrogen fertilizers and 400 pounds per acre is usually ample on other types of soil. Nitrogen fertilizers should be applied just prior to planting the seed, sets, or seedlings or as surface applications while the crop is growing. If irrigation is available or if rainfall is adequate the available nitrogen supply can be conveniently regulated by surface applications. Heavy nitrogen fertilizer applications should not be made, especially on muck, unless ample phosphorus and potassium are known to be present.

Phosphorus.—Phosphorus fertilizers, especially when applied with potassium carrying fertilizers, hasten maturity and improve the keeping qualities. Phosphates, however, when applied alone often reduce the yield of onions grown on muck. As a rule, phosphate fertilization is needed more on acid than on neutral or alkaline soils.

Superphosphate rather than bone meal is recommended for onion culture because of its quick availability. Phosphate testing equipment is useful in determining whether or not the soil needs additions of phosphate fertilizer. Kits containing this equipment can be purchased or soil samples can be sent to the Department of Soils at the Ohio State University for analysis.

Fertilizer Formulas

It is impossible accurately to estimate the fertilizer needs of onion crops growing on a wide variety of soils, as these needs will differ from season to season and with the different types of soil. The following recommendations should, therefore, be considered as approximations. Frequent tests for available

phosphates and nitrates should help growers decide the relative proportions of the fertilizer elements which should be used.

For muck soils a 3-9-18 or a 0-12-12 fertilizer is commonly used. The former is used on soils showing low nitrate test (usually acid) and the latter on soils giving a high nitrate test.

For dark colored loam or clay loam soils a 3-9-18 or 2-12-6 fertilizer usually gives good results.

For light colored loam and clay loam soils a 2-12-6 formula is recommended.

For sandy soils a 4-10-6 formula is recommended to take care of the greater need for nitrogen.

As previously mentioned, all onion soils should be well supplied with organic matter. The organic matter supply of muck soils is adequate, but the supply in loam and clay soils should be supplemented whenever possible with applications of well rotted stable manure or by plowing under cover crops. Fresh stable manure should never be used on ground to be used for onion culture, because of the weed seeds which it introduces. Animal manures also add available nitrogen, phosphorus, and potassium to the soil.

If the above fertilizer proportions do not produce the desired effects a careful study should be made, including soil analyses. If the crop matures too late, more phosphorus and potassium and perhaps less nitrogen should be used. If the crop matures too early, more nitrogen and less phosphorus should be used. If the crop grows slowly in the spring and the foliage turns light yellow in color it is probable that nitrogen is needed.

Complete fertilizers are usually applied at the rate of from 600 to 1500 pounds per acre. On muck soils only muriate or sulfate of potash at the rate of 200 to 400 pounds per acre should be used if less than 600 pounds of fertilizer are applied.

Methods of Applying Fertilizers

Commercial fertilizers for onions are usually broadcast a short time before the soil is finally prepared for planting the seed, sets, or seedlings. Complete fertilizers and fertilizers containing phosphorus or potassium should be applied so that they lie 2 to 4 inches under the surface of the soil. Soluble nitrogen fertilizers should be applied as surface applications. Animal manures (well rotted) should be applied and plowed under in the fall.

A more profitable use of a limited amount of commercial fertilizer can be secured by applying it below and on either side of the seed in the drilled rows. There are, however, no suitable combination seed and fertilizer drills and the expense involved in applying the fertilizer by separate operation does not warrant the practice. The excessive traction necessary to operate combination drills causes the wheels to drag on muck and in addition requires more power for operation. A suitable combination drill drawn by horse or gasoline power would place the fertilizers where they are most needed and help reduce the cost of applying fertilizers. It is not, however, safe to apply more than 500 pounds per acre in the rows near the seeds. If more than 500 pounds are used the remainder should be broadcast.

Soil Preparation

Land that is badly infested with weeds or weed seed should not be used for onions, as the cost of controlling the weeds would be excessive. Weedy land should be used for corn or potatoes or similar crops in which the weeds can be more easily controlled.

Most growers advocate fall plowing so that they will be able to plant the onion seed more quickly when favorable spring weather arrives. Fall plowing is especially important for clay or loam soils. Opinions differ regarding the best date to plow muck soils. Some believe that fall plowed muck soils are firmer and will blow less and others hold the opposite to be true. They claim that the action of the frost mellows and loosens the plowed muck so that it is more easily blown. At any rate the muck after being plowed, disked, and harrowed

Fig. 3.—Muck soils should be compacted by means of a roller as soon as they are prepared in order to prevent the soil from being blown from place to place.

should be compacted by means of a roller in order to reduce blowing to a minimum. These rollers supply a pressure of not less than 1600 pounds per yard of length (see Fig. 3).

Prior to planting, a drag is frequently drawn over the field to smooth the surface so that the mark made by the seed drill marker can be seen more easily.

Varieties of Onions for Ohio

The Yellow Globe Danvers and Ohio Yellow Globe varieties are good keepers and are grown most extensively in Ohio for the late crop. The Southport Yellow Globe is also grown. The Ebenezer variety is used extensively for yellow bottom sets. The Southport Red Globe is grown for mature bulbs and for red bottom sets. The Southport White Globe is the most popular white variety for mature bulbs. Silver Skin is grown for white bottom sets,

for mature bulbs, and for pickling onions. The White Portugal is grown occasionally.

For green bunch onions the Potato onion and Perennial Tree onion sets are used. The Potato onion sets are often erroneously called Shallots.

For transplanting purposes the Spanish sorts, such as Prizetaker, Riverside Sweet Spanish, Denia, Valencia, and Gigantic Gibraltar are used. These are really all strains of the same variety and have recently been very successfully grown from seed planted in the field in Ohio. The White Bermuda, Ailsa Craig, and Crystal White Wax seedlings are also used occasionally for transplanting in Ohio.

Seed should be secured from reliable dealers to insure freedom from variety mixtures and unproductive strains. It is not possible properly to grade onions that are mixtures of colors and varieties.

Fig. 4.—Multiple row seed drills are frequently used to plant onions on muck in Ohio. Note the handle on the left used to guide the drills.

Sowing the Seed

Germination tests should be made as soon as the seed is secured in order better to judge the thickness of planting. From 3 to 6 pounds of seed are required to plant an acre. The lesser amounts can be used if germination is excellent, provided the seed is sown on soils such as muck, which do not form crusts above the small seedlings. For heavier types of soil more seed is needed. In order to avoid thinning it is essential not to plant more seed than necessary.

Seed should be sown in Ohio the first two weeks in April. Later sown seed often results in much lower yielding crops. If the ground has been fall plowed the early spring planting is facilitated.

Seed is sown from ½ to 1 inch deep, depending upon the type of soil and its moisture content. Seed drills used singly are used for planting small

acreages. One man can easily plant an acre a day with one drill. Larger acreages may be planted by fastening two or more drills to special attachments which may be drawn by garden tractors. Multiple row cultivator attachments are also available for cultivating onions but their use is not general as considerable skill is required for their successful use. Rows are usually 12 to 14 inches apart; the 12-inch distance is a little close for convenience in cultivation (see Fig. 4).

It is very essential that the seedbed be well prepared before seeding operations start. If harrows are used for the final conditioning the harrows should be drawn in a direction opposite to the way the rows are to be planted, so that the marks made by the seed drill marker will not be confused with the furrows made by the harrows.

Cultivation

It is extremely important to start cultivating onion fields as soon as the onions can be seen, otherwise the weeds will get beyond control. Cultivators with cutting blades (see Fig. 5) are more effective in killing weeds than those equipped with shovel or similar appliances.

Cultivations should always be shallow and frequent enough to keep the weeds under control. By carefully adjusting the knives on the cultivators it is possible to kill all but a few weeds which are directly in the onion rows. Deep cultivations kill many onion roots and cause considerable damage. Six to ten cultivations are usually required during the growing season.

Fig. 5.—Cultivators with cutting blades are effective in killing weeds.

It is important to plant onions in straight rows so that but few plants will be killed by cultivation. Special attachments are available for opening narrow furrows in soft spongy soils.

Multiple row cultivators can be used if the rows are made straight and parallel.

Hand Weeding.—Even though great care has been taken in cultivating the onions it is always necessary to do some hand weeding. Small boys and girls are usually employed for this work, because they can do it more easily than mature men (see Fig. 6).

Weeds should be removed while they are very small and while the soil is moist. They rob the onion plants of moisture and fertility and crowd and shade them. If weeds are allowed to grow so that the onion rows cannot be seen easily the field should be plowed and used for another crop, as the cost of weeding such a crop would be too great.

Fig. 6.—Onions should be hand weeded before the weeds get thoroughly started.

Windbreaks

Dry muck is easily blown by brisk and strong winds. The muck particles strike the onion plants with great force and cause much damage. Occasionally the muck drifts so that the seed and plants in certain areas are covered to considerable depths while in other areas the seed and plants are left without sufficient soil.

Willow windbreaks and plantings of rye placed where they will break the force of the wind help to prevent the muck from blowing (see Fig. 7). Burlap windbreaks are also used very extensively as supplementary protection (see Fig. 8). Strips of burlap 36 inches wide are secured to 2 by 2-inch stakes by means of laths extending the entire length of the stake to give the greatest

Fig. 7.—Willow and rye windbreaks. Note the absence of onions to left of the rye. The protection afforded by the willows saved only about half of the planting to the left of the rye so that it was necessary to replant a portion of the field.

Note the onion plants on the right of the rye when the force of the wind coming from the left, was broken by the rye.

Fig. 8.—Burlap windbreaks are used extensively in Ohio.

binding effect so that the burlap will not be torn. The stakes are driven into the soil about a rod apart. The location of the burlap windbreaks depends somewhat upon the location of the fields and other windbreaks. Where burlap alone is used it is necessary to erect windbreaks as close as 50 yards from each other.

Harvesting and Curing

The tops of properly grown onions will wither at points approximately one inch above the bulbs, thus causing the foliage to drop to the ground. As a rule the crop should be harvested as soon as this stage is reached, as the cured crop is much less likely to rot. Late fall rains, cold winds, freezing temperatures, and other unfavorable fall weather is responsible for the loss of many onion crops.

Frequently the onion top remains green and thickened near the bulb and ripens progressively from the tip downward. Such onions are called scallions. They may be caused by one or more unfavorable growing conditions. Excessively cold temperatures for prolonged periods frequently cause scallions. In fact, seed production accompanied with double bulbs and thick necks is dependent to a large degree upon prolonged cool weather during certain stages of growth. Improper fertilization, and disease and insect attacks, especially thrips, may also cause scallions. Scallions should not be marketed. They do not keep well and their unattractive appearance lessens the immediate sales value of the entire crop if they are not graded out.

When the bulbs are sufficiently matured they are pulled and six to eight rows placed together in a windrow so that the bulbs are protected from sunscald (see Figs. 1 and 9). This is accomplished by laying the tops over the bulbs. Onions are allowed to cure for from 3 days to 2 weeks in the windrows, the length of time depending somewhat upon the weather. During hot dry weather the shorter period will suffice. It is frequently necessary to turn the onions with wooden forks or rakes when they become thoroughly wet from prolonged rains.

White onions must be given more care to avoid losses from rot organisms. They are especially susceptible to a smudge disease which does not develop on pigmented (yellow or red) bulb scales.

As soon as the bulbs are cured—that is, as soon as the tops are thoroughly withered, the tops should be removed. This may be done by hand or by means of onion toppers (see Fig. 10).

The topped onions are placed in slatted crates with suitable covers, and left to complete the curing process in the field until they are either sold or placed in storage. They should be sold or placed in storage before freezing weather.

Onions which are dug and left lying on top of the soil are more susceptible to frost injury than undug bulbs. Frozen bulbs or bulbs which are exposed to freezing temperatures should not be moved or handled. Frozen tissue appears to be "water-soaked, discolored, and more or less transparent with indefinite scattered opaque areas." Injury usually includes one or more entire scales. If only the outermost scales are injured the bulbs can usually be salvaged if they are carefully dried.

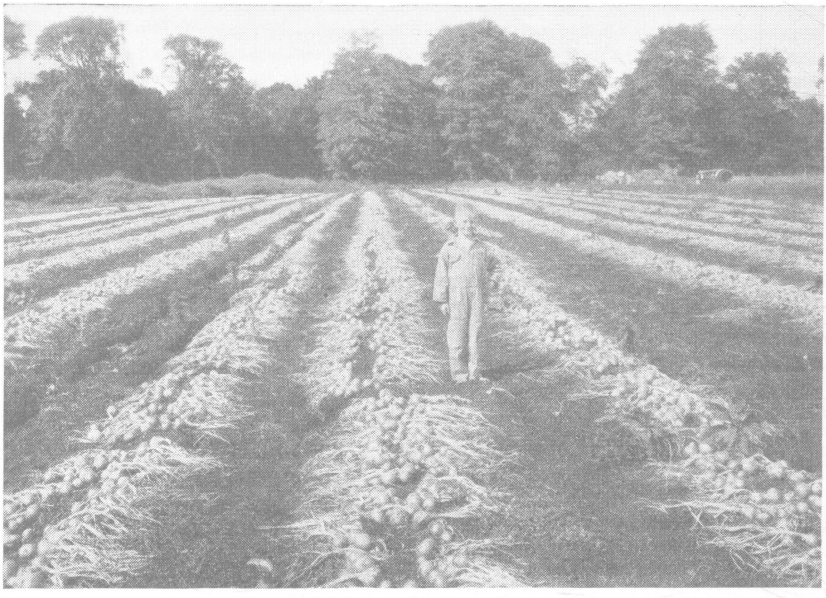

Fig. 9.—Some growers allow the onions to cure as shown in this illustration claiming that they get little or no sun scald. Note the large size of the onions which netted the grower more than double the market price because of their size and quality. The large size was made possible during the 1930 drought by thin seeding and by subirrigation in addition to heavy fertilization.

Note the large cracks in the muck which has been allowed to dry in order to facilitate the curing process.

Fig. 10.—Onion toppers afford an economical means of removing the onion tops.

Growing Onions from Sets

Bottom sets or small ripened onions can be used for the production of a crop of mature bulbs or for green bunch onions. They are much more likely to produce a satisfactory crop than seed, because a considerable portion of the food necessary for the ultimate bulb is stored in the bulb which is planted. The home gardener usually uses sets rather than seed because he is thereby more likely to secure a satisfactory crop. Many commercial gardeners are now planting sets rather than seed partly because of the larger yields secured from sets and partly because the crop from sets matures somewhat earlier than the crop from seed. The intermediate crop of onions from Iowa is grown from sets and they usually bring a better price than the late crop produced in Iowa from seed.

It is claimed that sets are not satisfactory on the muck soils of Ohio. It is possible that sets on muck should be fertilized with a more liberal supply of available nitrogen in order quickly to utilize the food already stored in the bulbs for the formation of new tissue. Insect and disease pests, including possibly virus diseases, may also be carried more easily on sets than on seed. This may become a serious disadvantage of the set method of onion production.

Sets from ½ to ¾ inch in diameter should be used. Smaller sets do not contain sufficient food reserve and larger sets go to seed too easily.

Sets should be held at a temperature of 32° F. during their dormant period, which usually is during the winter. If held at temperatures of from 40 to 55° F. the sets are almost sure to produce seed and scallions or thick-necks rather than the desired bulbs. If stored at temperatures of 60° F. or above they will not readily go to seed when planted, but the bulbs do not keep well at these high temperatures. It is likely that the onion set industry and the raising of mature bulbs from sets will be greatly expanded when more sets are kept over winter at the proper storage temperatures.

Sets, like seed, should be planted as early in the spring as the soil can be prepared. If they are planted for green onions they should be placed upright in trenches and covered with about an inch of soil. It is not necessary to place the sets in an upright position if mature bulbs are being grown. The planting of sets by hand is rather expensive. Commercial growers are, therefore, using one or two-row set planters. These planters require considerable more power for their operation than seed drills because a deeper furrow must be made to receive the relatively larger sets and additional power must be furnished to keep an agitating device in motion. This agitator keeps the sets uniformly distributed at the opening in the bottom of the hopper which holds the sets. It is possible for an extra strong man to plant an acre per day with a single row set planter. Tractors are, therefore, being used more and more as sources of power.

The cost of sets is much greater than the cost of seed. Weed control with onions grown from sets is much less expensive and in some instances this saving is sufficient to offset the extra expense of the sets. The larger crop secured from sets usually makes this crop more profitable on clay and loam types of soils than the crop secured from seed. Plants from sets are, if properly planted, able to break through the crusts formed on most soils.

It requires from 10 to 30 bushels of sets to plant an acre, depending upon the size of the sets. The sets should be graded into several sizes before they are planted to remove excess scales and to facilitate the adjustment of the set planter. Sets should be placed about 3 inches apart in rows 12 to 14 inches apart.

It will be necessary to adjust the planter for each different size of sets. Sets larger than ¾ inch in diameter should not be used, as they are very likely to go to seed rather than produce larger bulbs. If seed stalks should form in spite of all precautions they should be broken off as soon as they form. As soon as the crop is matured it should be pulled, cured, and placed on the market in order to avoid competition with the larger late crops produced from seed. Bulbs produced from sets do not keep so well as those produced direct from seed.

Growing Onion Sets

The ordinary bottom sets are small onions whose growth has been checked by crowding and in some instances by late plantings on soils of low fertility. The largest yields are, however, obtained by planting from 80 to 100 pounds of seed per acre on very fertile soil. This is at the rate of approximately 200 seed per foot. On less fertile soils the proper sized sets are secured with from 30 to 40 pounds of seed per acre.

The seed is usually planted early in the spring, although delayed plantings are sometimes used to insure the desired smaller size. Late plantings do not as a rule yield as heavy as early plantings. The usual narrow opening plow attachments on seed drills are usually replaced by extra wide attachments with special coverers for planting seed for sets. The cultivation and fertilization of the onion set crop is the same as for the mature bulb crop except that thinning is not practiced.

The tops of the sets are twisted off at the time they are pulled. Pulling starts when the tops start to turn brown but while most of the tops are still quite green. In order to facilitate pulling a special U-shaped tool attached to a cultivator can be run under the rows to loosen the soil and sever the roots. The onions are cured in ventilated crates which are placed in ventilated storage houses or stacked in the field and protected by a temporary roof of boards and waterproof paper.

Bulbs from ½ to ¾ inch in diameter are the most desired. Smaller sets should be discarded. Larger sets, especially white ones, can be separated and sold for pickling purposes. If pickling onions are desired less seed, say about 25 pounds per acre, should be used. Sets should be cleaned by running them through a machine similar to an ordinary fanning mill.

Good keeping varieties are ordinarily used for set production. Yellow Strasburg, Japanese or Ebenezer, Red Weathersfield, and White Silver Skin are the varieties commonly grown for sets. Most of the onion sets in this country are grown near Chicago, Illinois, and near Racine, Wisconsin. Some sets are grown in Kentucky. They are grown on a black loam soil near Chicago and on muck in the Racine, Wisconsin, district.

Growing Onions by Transplanting

Most of the so-called Bermuda onions grown in Texas, Louisiana, and California are produced from transplanted seedlings. These seedlings are grown in the south in specially prepared seedbeds and set in the permanent growing field by means of cheap labor, although transplanting machines are now available which do this work satisfactorily. The White Bermuda (really yellow) and Crystal White Wax are the varieties most used.

Approximately 20,000 acres of these onions are grown annually in the southern states. They reach northern markets after the bulk of the late crop onions are sold and due to the limited supply and also to their excellent quality they usually sell for a higher price than the late crop onions produced in the northern states.

Many carloads of the onion seedlings are shipped north each year and they are grown in home gardens and to a limited extent by commercial gardeners. The seedlings are also occasionally grown by commercial gardeners in the north who plant the seed in hot beds or greenhouses about the first of February.

The seedlings, about the size of a lead pencil, are transplanted in Ohio about 2 inches deep in fertile well prepared soil about the 1st to 20th of April. From 100,000 to 125,000 plants are required to set an acre if the plants are set 4 inches apart in rows 12 to 14 inches apart. In order to facilitate transplanting, the tops of the seedlings are usually trimmed to within 3 or 4 inches of the roots. The plants can be set by means of a dibber or placed in a furrow opened by hand operated tools. In transplanting, care should be taken to cover all of the roots of the healthy seedlings with well firmed and moist soil. The crowns of the seedlings should not be covered with soil.

The transplanting operation, even with machinery, is expensive and it is not likely that this method will be generally adopted in northern sections, although onions of excellent size and quality can be matured a little earlier than from seed sown directly in the field.

Bermuda onions are poor keepers and should be consumed as soon as they mature or placed under exceptionally good storage facilities.

Green Bunch Onions

Green bunch onions are especially appetizing in the early spring months. To meet the demand at this season of the year many home gardeners and a considerable number of commercial gardeners grow one or more kinds of green onions. In order to secure a crop at the earliest possible moment most of the bunch onions are grown from sets. Ordinary bottom sets, similar to the kind already described, are frequently used, although a still earlier crop can be secured from fall planted Egyptian onion sets which are also known as Perennial Tree onion sets, or from the Potato onion. The former onion is the hardier of the two and can be grown from either the top or bottom sets. The Potato onion is propagated from bottom sets only. They are often erroneously called Shallots.

The small bulbs when planted will, if left to grow, mature into large bulbs though the large bulbs will, when planted, split up into a number of small sets. The yellow, red and sometimes white varieties of these sets can be obtained. For an early crop the small sets should be planted in trenches about 4 inches deep about the first of September. As they start to grow the trench should be gradually filled. Partially grown onions will result. They will resume their growth the following spring and produce edible shoots very early.

Chives which are propagated by the division of the clumps are a perennial and are bunched and sold at all periods of the growing season. They are quite mild.

Garlic, on the other hand, has a very strong flavor. It is propagated from the small cloves which are planted much the same as onion sets. Garlic is usually sold in bulk or in braids and is not bunched.

The bunching of green onions requires considerable time and care. A mechanical tying machine is very helpful. Gardeners who are not especially equipped for bunching vegetables rarely make any profit from bunch onions. They grow them primarily as an accommodation for the trade. The removal of the outer scale helps whiten the product and enhances its attractiveness but requires more work.

Onion Seed Production

Most of the onion seed used in Ohio is grown in California. The seed of the Bermuda varieties is imported from the Canary Islands. Even though it is difficult to cure seed in Ohio, it frequently pays large growers to save seed from a specially desirable strain or variety.

Bulbs about 1½ inches in diameter which are true to type and which come from stock of known yielding capacity are planted 4 inches apart in the bottoms of trenches 3 feet apart. The bulbs should be planted as early as possible on land, preferably muck, which has been well fertilized with potassium.

The crop is given the usual cultural care during the growing season. When the heads begin to turn yellow they should be clipped off and placed in ventilated crates or on canvas to dry. When dry the seed is flailed or threshed with special threshing machinery. A portion of the chaff and light seed can be blown away when the seed is run through a cleaning mill. Light seed can also be separated by removing that which floats when placed in water. Ample precautions should be taken to insure the proper drying and curing of seed grown in Ohio.

Irrigation

Reference has already been made to the advisability of utilizing drainage systems during dry weather for irrigation systems. The overhead type of irrigation is, however, frequently used on muck (see Fig. 12). Water applied from overhead lines not only supplies moisture for growth but may serve also to prevent the blowing of muck, to prevent or extinguish fires and in excep-

Fig. 11.—A portable pumping plant which supplies water for irrigating crops grown on the muck in the background.

Fig. 12.—Excellent crops of onions can be grown from seed or sets on silt or clay loam soils if irrigation is used.

tional cases to apply water which protects crops against severe frosts and freezes.

The use of irrigation is almost essential for large yields of onions on silt and clay loam soils (see Fig. 12). Onion growers not equipped for irrigation but who have a supply of water near can often secure profitable yield increases by damming up streams thus raising the water table of muck soils. The furrow system of irrigation can be used cheaply on level soils of heavier texture if these soils are near a convenient source of water.

Rotations

Reference has been made to the low yields of onions secured by Ohio growers. Evidence is being secured which indicates that these low yields are

Fig. 13.—A two-row potato planter used for planting potatoes on muck. Potatoes are often profitably used in the rotation with onions.

due in a large degree to a lack of proper rotations. Onions should not be grown on the same ground continuously, possibly once in three years would be often enough. Little is known about the best rotations for Ohio. Growers are, however, successfully growing potatoes, turnips, carrots, beets, and parsnips on muck soils. All of these crops respond to approximately the same fertilizer applications as do onions. A few growers are also growing celery, spinach, and lettuce. All of these crops except potatoes and celery can be planted and cultivated with the same equipment that is used for onions. The same storage houses can be used for most of the crops. A special planter (see Fig. 13) is used for potatoes and a transplanter should be used if large acreages of celery are to be grown.

Storing the Crop

Approximately 30 to 50 per cent of the onion crop is placed in storage, the rest being shipped from the field or from temporary storage. The shrinkage in storage usually amounts to from 7 to 15 per cent. Part of this shrinkage is due to loss of weight resulting from moisture loss or to the consumption of carbohydrates through respiration. A good portion of the preventable loss is due to sprouting and to rots of various kinds. The former can be held in check by keeping the temperatures of the storage houses as near 32° to 34° F. as possible. The loss from rots can be prevented in part at least by harvesting at the proper time (see Fig. 14) by not allowing the bulbs to lie exposed in the

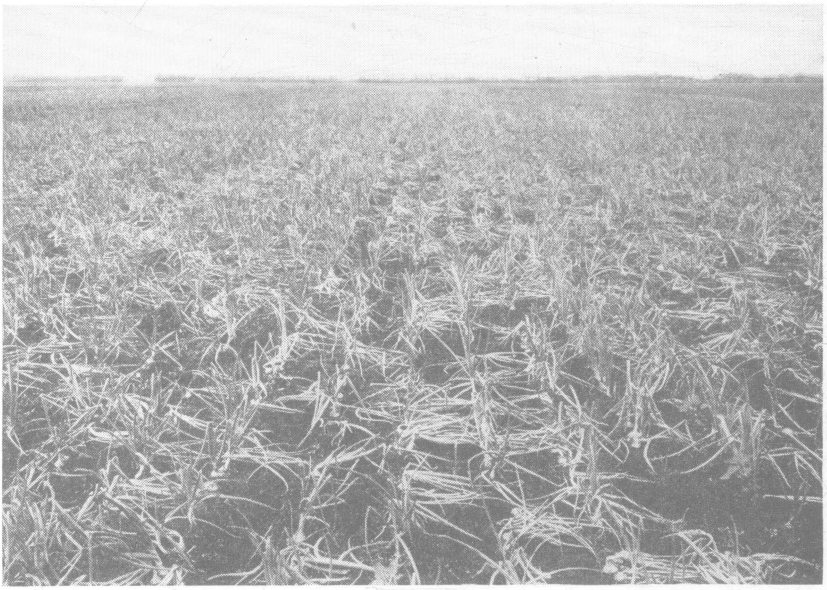

Fig. 14.—Onion tops should fall over at a point about one inch above the bulb before they are harvested. The onions in this field were not ready to be harvested until a week after the photograph was taken.

field any longer than necessary, and by regulating the temperature and humidity of the storage houses. A relative humidity of from 50 to 70 per cent is assumed to be correct for onion storage.

Storage houses should be well insulated so that they will not be subject to rapid fluctuations of temperatures (see Fig. 15). In Ohio onions should be placed in storage during October. The houses should be left open on cool nights and left closed on warm nights during the early storage period. As the outside temperature falls, the houses will be kept closed to prevent freezing, except that a gradual change of air must be provided for the purpose of ventilation. It will be necessary to heat the houses during the coldest periods.

Onions in storage houses should be placed in slatted crates to allow a free circulation of air. Space should also be left between all sides of the crates for air circulation. Forced air circulating systems are used in some houses.

Onions should not be allowed to freeze. Slightly frozen onions if kept in a dry comparatively warm place (50° F.) for a short period after freezing can often be sold, even though they may be somewhat withered due to the destruction of several layers of scales.

Scallions, doubles, splits, sprouted onions, and blemished onions should not be placed in storage.

Marketing the Crop

The most important factor involved in marketing a crop of onions is that of growing, maturing, and harvesting the right kind of a crop. Crowded onions even on muck will not produce a high percentage of U. S. No. 1 onions. On the other hand, a perfect but not crowded stand (see Figs. 9 and 14) if

Fig. 15.—An onion storage house. Note windows and ventilators.

given proper cultural advantages will produce almost all U. S. No. 1 onions. Likewise onions that have been harvested prematurely or onions that have remained exposed to unfavorable elements in the field cannot grade a high percentage of desirable onions.

The late crop onions grown in Ohio are sold almost entirely by large growers or through dealers and distributors who may also be growers. They are usually placed in open mesh burlap or saxoline sacks. During freezing weather six rows of these sacks are placed in the centers of the cars with straw along the sides and ends to provide protection against freezing injury while in transit.

All onions sold by Ohio growers should be graded to meet U. S. standards. Onions which are definitely graded can be sold with a definite index of value. This index of value is of considerable importance to both grower and buyer.

Onion Diseases

By A. L. Pierstorff,
Extension Plant Pathologist, The Ohio State University

Onion Smut

Onion smut, caused by the fungus *Urocystis cepulae* Frost, has been known in this country since 1860. It is now present in all of the northern onion sections where the crop is intensively grown. Smut attacks all varieties of onions grown commercially in this country and sometimes causes loss on leeks and shallots.

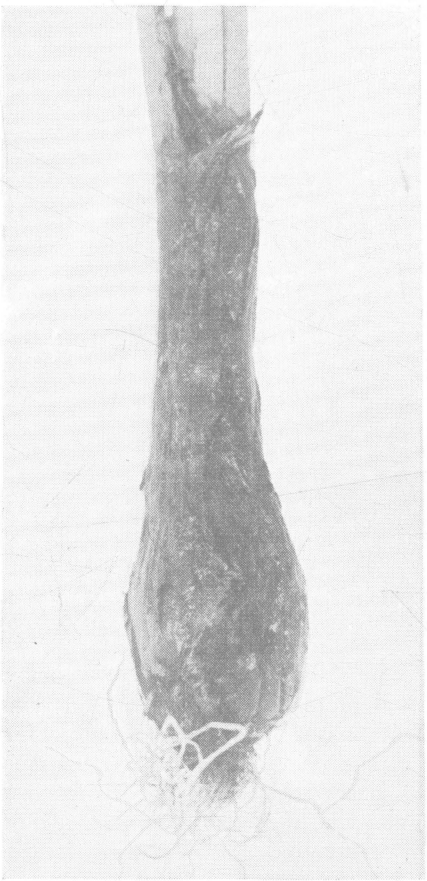

Fig. 16.—Onion smut.

Description.—Onion smut can be first noticed in the young seedlings as dark streaks within the foliage, especially if held against the light. Affected leaves are apt to be twisted and distorted, and upon opening them, one finds a mass of black powdery spores.

Later, the smut may burst the foliage or leaf-sheaths, exposing longitudinal masses of black spores (see Fig. 16). These spores fall to the ground where the fungus is able to live for a number of years, either as spores or mycelium.

Onion seedlings may be attacked from the time they are 2 days old until they are 15 days old. The length of time the seedlings are susceptible varies with the growing conditions. The more favorable the growing conditions the shorter the time the seedlings are susceptible.

The onion smut fungus will grow at just as low a temperature as the onions will grow, but at 75° F. many seedlings escape infection. Above 85° F. little or no infection occurs. This is the primary reason why smut is a problem of the northern cool climates. Ohio is just cool enough to come in for its share of smut, but it is not as severe here as farther north.

Control.—Onion sets and bulbs planted for seed are immune. Where smut is severe a small acreage can be grown from sets. Rotation of crops is of little avail against smut.

Where onions are grown from seed in soil known to be infested with smut, formaldehyde should be sprinkled in the row with the seed. One pint of formaldehyde should be diluted with 16 gallons of water and used at the rate of 200 gallons per acre. Some growers have used one gallon of formaldehyde to 50 gallons of water applied at the rate of 50 to 60 gallons of solution per acre when the soil is very dry; 60 to 70 gallons when the soil is medium wet; and 80 to 90 gallons when the soil is very wet. This stronger concentration sometimes results in considerable injury.

The solution is best applied with a tank fastened on the drill. The tank should have a screw top which is air tight and a stand pipe a little higher than the top of the tank soldered into or near the bottom of the tank, so there will be an even flow of liquid. Without the screw top and standpipe the liquid will run out much faster when the tank is full than when about empty.

For several years formaldehyde dusts made by impregnating equal parts of kaolin and infusorial earth with formaldehyde have given promising results and may in time replace the liquid or drip method.

Neck-Rot of Onion

At least three species of *Botrytis* have been described as causing neck-rot of onion. It is difficult for the layman to distinguish the different kinds of neck-rot. This, however, need not concern the grower, as all three rots cause the same type of injury and are increased or decreased by the same environmental factors and the succulency or the maturity of the host. It has been clearly demonstrated that white varieties are more susceptible to neck-rot than red or yellow varieties. However, when once infection has taken place, all varieties rot with about the same rapidity.

Description. — Neck-rot (see Fig. 17), is principally a storage trouble and seldom attacks onion bulbs while they are still in the ground, but injured foliage may be attacked even when the plants are quite young.

The tissue about the neck of the onion may become sunken and have a dried out appearance. A gray mold with many black kernel-like bodies (sclerotia) may appear about the neck of the onion or cover most of the surface.

The inner scales are soft, appear as if they had been cooked, and have a light,

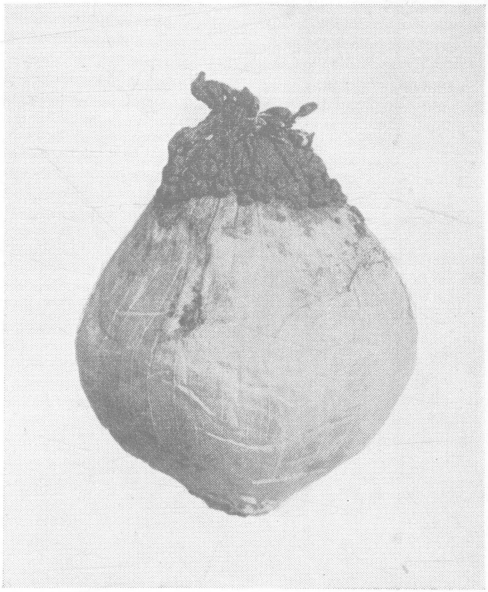

Fig. 17.—Neck rot of onions.

brownish color. Between the scales the mycelium of the fungus may be noted in gray masses. When soft rot bacteria follow neck-rot the entire onion is reduced to a soft, wet, foul-smelling mass.

Control.—Temperature and moisture, together with maturity of the onions, determine the amount of neck-rot which will develop in any given season. The first two factors have been shown to have a greater influence than the maturity of the crop. Topping of the onions increases neck-rot, but perhaps not sufficiently to recommend the storing of untopped bulbs. The use of artificial heat, together with forced ventilation, has given good control of neck-rot and should be employed where economically possible. When two or three weeks of warm dry weather follow harvest, the loss from neck-rot is negligible. When the opposite kind of weather prevails, especially if the onions are immature, the loss is tremendous.

Care should be exercised to prevent bruising of the crop while harvesting. All scullions should be discarded immediately and an attempt made to dry the crop as quickly as possible. Cultural practices which will hasten the maturity of the crop should be adopted and an attempt made to harvest the crop as early as practicable.

Smudge of Onions

Onion smudge, caused by the fungus *Colletotrichum circinans* Berk. Vogl., has been known in Europe for 75 years and now occurs in practically all onion growing districts in this country. Its greatest loss to the grower comes from marring of the surface of the onion by its unsightly black blotches, thus reducing the crop's salability, and from the shrinkage caused in storage.

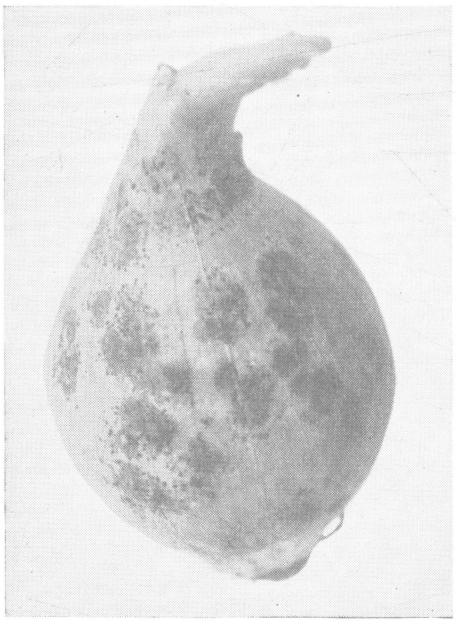

Fig. 18.—Onion smudge.

Description.—This disease is known best by the black or dark green blotches on the neck or sides of the onion, especially white skinned varieties.

If the black smudge spots (see Fig. 18), are closely examined with a hand lens it will be noticed that the surface is covered with stiff bristles and that the spots are usually made up of concentric rings instead of being a uniform black color. These sooty blotches are seldom if ever found on the pigmented part of colored onions. The reason for this is that the pigmented portions contain protocatechuic acid, which is toxic to the smudge fungus.

This disease may attack the onion at any time during its

life, but especially in late summer or early fall just before harvest, and later or again in storage and transit. Occasionally it causes a damping off of young plants in the field during warm weather.

When smudge is severe the fungus may grow through the dry outer scales into the fleshy scales beneath, causing the onion to shrivel in storage.

Control.—Since the fungus lives over winter in the soil, on onions and on sets, it is easy to see how it is carried from one crop to the next. Discarded onions, sets, or trash from the storage house should not be scattered

Fig. 19.—Pink root is shown on right; left shows normal size of roots.

over the soil which is to be used the following year for onions. At least a 2-year rotation should be used where smudge is serious.

The colored portion of onions is immune, and either yellow or red skinned varieties should be used which carry the color well into the neck. If some white onions are to be grown they should be planted on soil which has not grown onions for at least one year and preferably two years.

Pink-Root of Onion

Pink-root of onion was thought formerly to be caused by a species of *Fusarium*, but the evidence at present indicates that *Phoma terrestris* Hansen

is the casual organism. In either case it is evident that the fungus lives over from one crop to the next in the soil. Pink-root is present in practically every onion field in Ohio where onions are grown year after year, and causes heavy losses in some seasons.

Description.—Pink-root is the most descriptive symptom of this disease. If one pulls up a number of onion plants which appear to be stunted and smaller than their neighbors, it will be noticed that the feeding roots are few in number and that some of them have a pink color. The feeding roots, after being attacked and killed by the fungus, rot and disappear.

The onion plant sends out new roots continuously, but this utilization of food products is a continual drain on the plant and normal growth is arrested. Sometimes almost 100 per cent of the plants in a field are attacked and it is difficult to measure the loss, since there are no normal plants with which to compare the yield. High temperatures and low soil moisture tend to favor the growth of the parasite and at the same time reduce the host vigor. During such seasons, losses are usually severe.

Control.—Attempts to treat the soil, sets, or seed for pink-root have met with universal failure. The best control is to be secured by growing the crop rapidly by use of fertilizers high in nitrogen. The soil should be so cultivated as to leave the field level at all times in an effort to prevent drying out of the roots. Good cultural practices throughout which will grow the crop under as nearly optimum conditions as possible, will enable the onion plant to withstand better the attacks of the pink-root fungus and thus decrease the loss to a minimum.

Onion Insects

By M. P. Jones,
Formerly Extension Entomologist, The Ohio State University

Onion Maggot

The adult of the onion maggot is a grayish-colored fly very closely resembling the common house fly in size, but when at rest the wings overlap on its back, making it appear longer and narrower than the house fly. It is sluggish and usually flies short distances when disturbed. (See Fig. 20.)

Life History.—The eggs are white and very minute. They are laid between the loose husks of the onion, or in cracks and crevices in the soil about it. They may be laid singly or in groups of 20 to 30 per plant. An egg hatches in from 2 to 10 days into a tiny maggot, which works its way down to the base of the plant from where it proceeds to work its way up through the inner tissues of the green onion. One maggot may attack as many as twelve onion seedlings in a row.

When the onions are large the entire larval life of several maggots may be spent within a single bulb. The full grown maggot is about one-third inch in length. Maggots usually leave the bulb and pupate 1 to 3 inches below the surface of the ground. Maggots of the third brood pupate mainly in the soil, although some may be found in the culls in the field and inside the onion

bulb in storage. The insect lives over winter in the pupal stage, but some full grown maggots survive in the onions. Occasionally adult flies live over winter in storage houses, but usually die before they lay any eggs in spring.

Damage to the onions is caused by the maggots. When they feed upon the seedlings the small plants wilt, change to a bluish or grayish tinge and finally die. The adult flies, which appear later, apparently are attracted to the decaying onions because the greatest damage to the crop is done in areas where the primary infestation occurred. The presence of maggots in mature bulbs often cause onions to rot in storage. The adult flies emerge quite early in the spring and for this reason control measures must be started early.

Fig. 20.—Center foreground, 7 rows unsprayed check (absence of onions due to onion maggot). Righ and left background, onions sprayed with Bordeaux-oil-emulsion. Insert shows adult fly, magnified.

Control Measures.—Very satisfactory control measures have been worked out. The most satisfactory results have been obtained by spraying the onions with Bordeaux-oil-emulsion. Spraying should be started when onions are about 1½ inches high and repeated at weekly intervals until six treatments have been applied.

Bordeaux-oil-emulsion is prepared by adding 1½ gallons of lubricating oil emulsion to 40 gallons of water. Lubricating oil emulsion either can be made at home or purchased on the market. To this mixture add 4 gallons of lime solution and 4 gallons of the copper sulfate solution, which have been prepared previously.

The lime solution is made by placing in a barrel 1½ pounds of fine spray lime, preferably 99 per cent 300 mesh, for each gallon of water used. Stir this thoroughly before using. Agricultural lime and coarse finishing lime are not satisfactory because they clog the spray nozzles.

Fig. 21.—A convenient commercial sprayer suitable for small acreage.

The easiest way to dissolve the copper sulfate (bluestone or blue vitrol) is to suspend the required amount for 12 hours in a burlap sack on the surface of the water. Use a wooden barrel and 1 pound of copper sulfate to each gallon of water. Oil emulsion and water without the copper sulfate and lime may be used, but the results are not so satisfactory.

The home gardener can get satisfactory control by treating onions with a solution of 1 ounce of corrosive sublimate to 10 gallons of water as for the

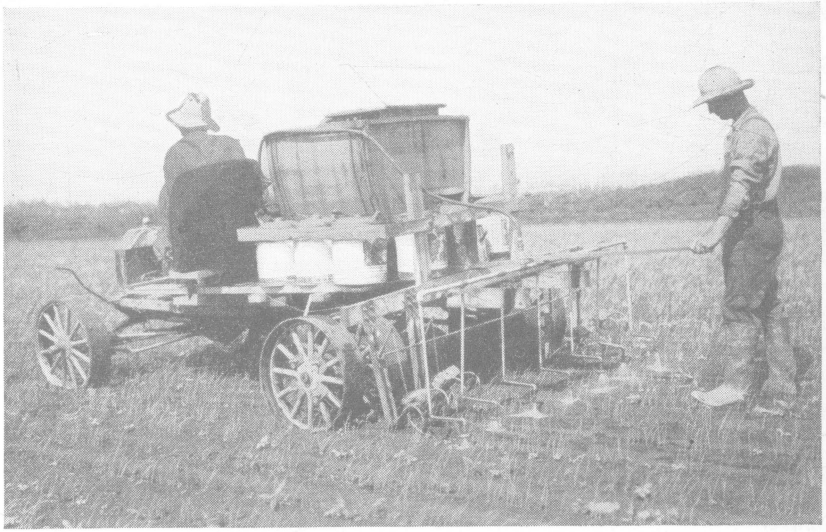

Fig. 22.—Home made onion sprayer suitable for large acreage.

cabbage maggot, but this material is too expensive to use on large plantings. The above mixtures have been found most effective when applied in the form of a coarse spray so that the base of the plant is bathed by the liquid and the soil soaked for a distance of 1 inch on each side of the row. The Bordeaux type nozzle is preferable. A fine mist is to be avoided. Twenty to twenty-five pounds pressure is adequate. From 120 to 150 gallons per acre is sufficient, or one gallon to 225 feet of row. Many weeds are killed by the Bordeaux-oil-emulsion in addition to controlling the maggot.

The greatest handicap in spraying onions is the lack of adequate sprayers which can be used on large plantings. For smaller plantings, tractor sprayers of the Bolins type are satisfactory (see Fig. 21), but these tractors are too small to spray rows ¼ to ½ mile long, as found in the onion fields of Hardin County. A potato or orchard sprayer with long leads of hose may be used, but these are unhandy. The power wheel hoes (see Fig. 22), was converted into a combination sprayer and cultivator. This proved quite satisfactory.

The cull onions may carry many maggots and puparia and should be destroyed not later than April 1. This may be accomplished by pouring old crank case oil over the culls and burning them.

The practice of scattering cull onions over the fields to be plowed under should be avoided. Poisoned bait traps have been tried and are of no avail.

Onion Thrips

Onion thrips, incorrectly called lice, are present almost everywhere and often cause severe damage to field onions in late summer. They are more abundant in dry seasons.

These insects are very tiny, yellow to brown, and not over 1/25 of an inch in length (see Fig. 23). The adult females have

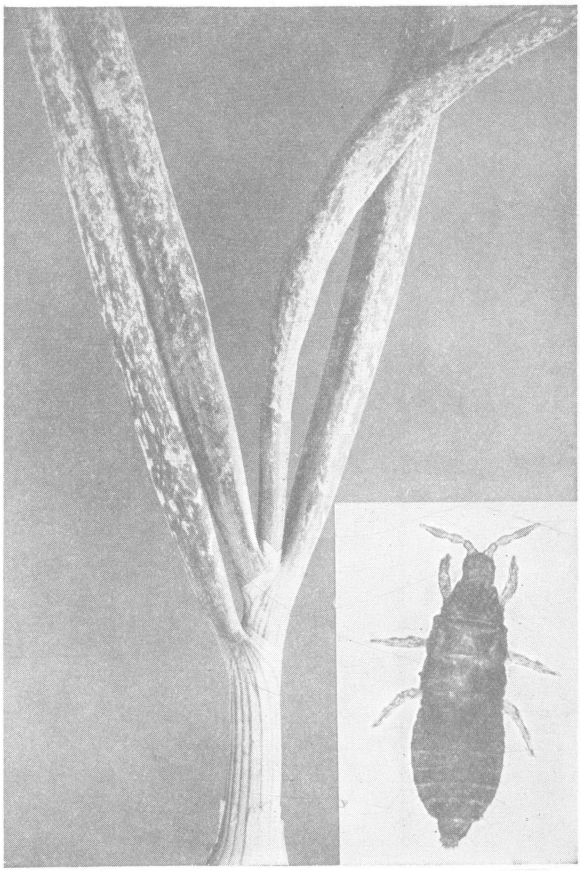

Fig. 23.—Injury from onion thrips. Insert shows adult, greatly enlarged. *(Conn. Exp. Station.)*

four very slender wings which are fringed on the posterior margin with quite long hairs. The males are wingless and very scarce.

Life History.—The female cuts a slit in the leaf of the host plant into which she inserts a tiny, bean-shaped, white egg. In from 5 to 10 days the eggs hatch into nymphs, which resemble the adult, except they are paler in color with bright red eyes.

The young pass through four stages, two of which are passed in the soil without taking food. The nymphal period lasts from 2 to 4 weeks.

After the fourth molt, the adult female returns to the plant to lay eggs for the next generation. Eggs, nymphs, and adults are found on the plants together and it is thought that there are about five or six generations each year.

Nature of Injury.—The insects abound between the leaves away from reach of insecticides. They feed by rasping the leaves and swallowing bits of plant tissue along with the juice which exudes. The injury from rasping produces a characteristic mottling of gray dashes and blotches on the leaves. As the amount of feeding increases, the leaves wilt, turn brown at the tips, and later fall over on the ground. The bulbs do not develop normally, but remain undersize and distorted, producing the so-called scallions. The insects have a wide variety of host plants, both cultivated and weeds.

Control Measures.—A satisfactory control measure remains to be found, but 40 per cent nicotine sulfate, 1 pint to 50 gallons of water into which 4 pounds of soap has been dissolved will give some relief. Best results from spraying will be obtained if high pressure is used and the nozzle held close to the plants so as to almost drench them.

The adults and nymphs winter in the crop refuse, weeds and rubbish in and about the field. Such material should be destroyed; also, when possible, burn the weeds in which thrips breed along the margins of the field.

Other Insects

Cutworms and wireworms sometimes cause injury to onions. Clean farming will prevent much injury from these insects. The greatest injury from wireworms is caused by species which live in wet soil and thorough drainage will fairly well control this species.

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