

How Good Lawns Grow



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HOW GOOD LAWNS GROW

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A smooth, vigorous green lawn is a desirable setting for any home and the ambition of most householders. Maintaining a good lawn is the constant concern of the home owner and those responsible for the care of public lawn areas.

For many years the Connecticut Agricultural Experiment Station has been doing research on how good lawns grow. Any lawn grows green until trouble strikes it. Consequently, most of our research has been aimed at learning more about the unsatisfactory lawn and how to make it grow well.

The most urgent and certainly the most difficult part of growing green lawns is the proper diagnosis of any troubles that appear. Unless the cause of injury is correctly identified, proper treatment is impossible. Many lawn troubles look alike unless one gives them intensive study. We have prepared this circular summarizing our experimental work and experiences in the diagnosis and correction of common lawn troubles. While no separate diagnosis section is included, a careful description of each disease, insect, or other cause of injury is given under the proper heading. If several things are suspected, it would be well to read carefully the description of each before attempting treatment, thus making sure that the correct control measure is used.

SOIL CONDITIONS

A good turf, regardless of the fertilizer treatment, rolling, watering, weed and pest control measures used, cannot be produced satisfactorily on sand, gravel or raw subsoil devoid of humus. There should be a depth of at least four inches of settled surface soil containing a sufficient amount of organic matter to give it a rich, dark brown color. Solid rock, gravel, sand or "hardpan", if present, should be 20 inches or more below the surface.

Many lawns must be developed on soils that are excessively sandy, poor in organic matter, or otherwise poorly suited to lawns. During the construction of new houses, excavating and grading frequently leave the land upon which the lawn is built in an unsatisfactory condition. However, the home owner who must build his lawn on an unfavorable site can do much to improve it.

Making a New Lawn

The best time for improving the soil is when the ground is being prepared for a new seeding. Then it is easy to add soil of satisfactory loaminess and organic content, especially in places where the top soil is too shallow or too sandy. The home owner is cautioned to exercise care in the purchase of "loam". Too often the soil purchased is very sandy, low in organic matter, and sometimes is a poorer soil than that on the home owner's lawn. Good loam has about equal proportions of sand, silt and clay and is fairly high in organic matter.

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Good loam is expensive. In the long run, however, the purchase of new loam will be less expensive than the cost of additional fertilizers, organic materials, etc., which must be applied to poor soils to keep good grass on them.

If the soil is of fair depth, but is too sandy, lacks organic matter, or is inclined to become excessively hard when dry, it will benefit from additions of organic materials. Any one of the following organic materials when worked into the soil to a depth of three or four inches gives good results. Lime should be applied in addition to the organic material used if a soil test shows the need for it.

TABLE 1. BENEFICIAL ORGANIC MATERIALS.

	Per 1,000 sq. ft.
Stable manure, rotted for several months to destroy weed seeds ..	½ cord
Granulated peat moss, dry	4 bales
Native moist peat, swamp muck or humus	2 to 3 cubic yards

Soil Testing

Before applying lime and fertilizers to the lawn area, it is suggested that a soil analysis be made to determine more accurately the proper materials to use. Soils to be purchased for the improvement of lawns should also be tested.

The lawn soil sample is obtained by taking samples of soil to a depth of 2 to 3 inches from 8 to 10 points well scattered over the area. The soil from these points should be thoroughly mixed together (after air-drying if wet) and about a pint of the mixture packed in a clean carton, box or bag not previously used for drugs, chemicals or other contaminating substances. Ice cream cartons are satisfactory soil sample containers. Soil areas which are obviously different should be sampled separately. Since soil test results are dependent on the soil sample, it is very important that representative samples be taken. Information on the past history of the lawn as to treatments should be included with the sample.

Lime

Many fertilizers tend to make the soil more acid. For example, sulfate of ammonia requires one pound of lime for each pound of this material. A moderate degree of soil acidity is not harmful to turf grasses adapted to this region. In fact, it appears to help check the invasion of numerous weed species, such as dandelion, broadleaved plantain and chickweed. However, high acidity will eventually do harm to turf grasses, especially Kentucky blue grass, and lime is necessary to counteract the acidity.

Fertilizers

Factory mixed fertilizers (Table 2) satisfactory for lawns can usually be purchased in stores handling lawn, garden or farm supplies. However, since most of the plant food elements are in a concentrated mineral form and are

quickly soluble, they must be used with caution. When mineral fertilizers are applied too heavily, or when spread carelessly, they will have a "burning" effect on the grass. Their quick availability provides more plant food than the plant can use, thus injuring the plant.

The fertilizer elements in organic fertilizers such as cottonseed meal, cow manure, bonemeal, etc. (Table 2), are slowly available. There is little danger of "burning" grass with heavy applications of organic fertilizers, but applying more than is necessary is wasteful and costly.

Fertilizers should be evenly distributed over the surface. One method is to divide the total amount of fertilizer to be used into two lots. Spread one lot going in one direction of the lawn and the second lot in a direction at right angles to the first one. A small fertilizer distributor is convenient for making this application.

Fertilizers applied to new lawns should be worked into the soil to a depth of three inches or more. On established lawns, fertilizers should be applied when the grass is dry preceding a rain, or they may be washed into the soil by a thorough watering with a garden hose or sprinkler.

TABLE 2. COMMON LAWN FERTILIZERS.

Fertilizers	Nitrogen %	Phosphoric acid %	Potash %	Rate of application per 1,000 sq. ft. pounds
Complete factory-mixed fertilizers				
General top dressing				
10-5-5	10	5	5	10
10-6-4	10	6	4	10
8-6-2	8	6	2	10
8-6-4	8	6	4	10
Establishment of new seedings				
5-8-7	5	8	7	20
5-10-5	5	10	5	25
7-7-7	7	7	7	15
Organic, chiefly sources of nitrogen				
Cottonseed meal	6.5	3	2	30
Castor pomace	5	2	1	35
Milorganite	5	2	1	25
Dried cow manure	1.8	1	2	100
Dried sheep manure	1.9	1.5	2	100
Dried poultry manure	2.5	2	1	75
Organic, chiefly sources of phosphorus				
Bonemeal, steamed	3	24	0	35
Bonemeal, raw	4	22	0	30
Inorganic, sources of nitrogen				
Nitrate of soda	16	0	0	5
Sulfate of ammonia	20.5	0	0	4
Uramon	42	0	0	2
Ammonium nitrate	32	0	0	2

Fertilizers containing more than 10 per cent of nitrogen, such as sulfate of ammonia, nitrate of soda or uramon, should be mixed with sifted loam or sand before spreading, or they may be dissolved in water and sprinkled on the turf, followed by liberal watering. They may be used as top dressing for spring or fall treatments on well established turf if soil tests show sufficient phosphate and potash present.

On established turf, fertilizer should be applied in early spring, not later than April 15, at the suggested rate. It is frequently desirable to make an additional top-dressing in late August, at about half the spring rate, especially if the turf has deteriorated during the hot summer months.

Turf grasses are usually most benefited by the nitrogen component of fertilizers. However, in general, well balanced complete fertilizers best serve to maintain the turf in a vigorous condition. In Table 2 several grades are given, all of which are satisfactory for lawns. Suitable grades for new seedings or for top-dressings on turf of unsatisfactory growth are 7-7-7 and 5-8-7 (the numbers refer to percentages of nitrogen, phosphoric acid and potash, respectively, in the order stated). Heavier rates of application on new seedings, up to twice the quantities recommended in Table 2, may be used at the time the soil is being prepared for the new seeding. High nitrogen-containing grades are well adapted to general top-dressing treatments.

SEEDING

September is the best time for turf seeding. Annual weeds offer less competition than in the spring. The young grass has the early fall and spring in which to develop and becomes more resistant to the adverse conditions of the following midsummer than grass seeded in the spring. Seedings in early October are frequently successful if cold weather comes late, but there is considerable risk involved.

Spring seeding, to be satisfactory, should be done in early April. Moisture conditions are usually favorable then, but the grass is slow in starting and weeds are more of a problem than with fall seeding.

The ground should be spaded or plowed, limed, if necessary, fertilized, and thoroughly raked and rolled to a firm, smooth surface before the seed is sown. The seed should be lightly covered by scratching the surface with an iron rake followed by a light rolling. Unless the soil is kept moist by rains, it should be sprinkled thoroughly when necessary.

The choice of seed depends upon soil, shade conditions and the type of turf desired (Table 3). Many good grades of commercial seed mixtures are available to meet different requirements. The quality of the seed is an important consideration, whether a prepared mixture is used or seed of the various species is purchased separately. A statement of the amount and kind of seed, germination, and weed seed content is required by law on each container of mixed or unmixed seed.

Numerous weeds of many kinds may appear conspicuously in newly seeded areas, and the seedman is often blamed unjustly for supplying contaminated seed. Such weeds almost invariably start from seed already in the soil or otherwise introduced. This is especially true of crab grass, a

common native grass. Crab grass seed is very rarely present in commercial lawn grass seed.

Seeding mixtures and rates for various conditions are given in the following table for those who may prefer to prepare their own.

TABLE 3. SEEDINGS FOR VARIOUS CONDITIONS.

Formula	Percentage of mixture, by weight	Lbs. of mixture per 1,000 sq. ft.
1. Blue grass, suitable for average lawn and park conditions		
Kentucky blue grass	80	4
Red top or Domestic rye grass	20	
2. Mixed grasses, for variable soils under average lawn conditions		
Kentucky blue grass	60	4
Astoria or Colonial bent	20	
Red top or Domestic rye grass	20	
3. Fescue, for sandy soils, dry shady locations and badly trampled spots		
Chewings fescue	80	5
Red top or Domestic rye grass	20	
4. Rough blue grass, for moist, heavily shaded areas		
Rough blue grass	80	4
Red top or Domestic rye grass	20	
5. Mixed grasses, for variable shade conditions		
Kentucky blue grass	40	4
Rough blue grass	40	
Red top or Domestic rye grass	20	
6. Mixed grasses, for steep slopes and elsewhere where rapid soil coverage is desired		
Kentucky blue grass	35	4
Chewings fescue	40	
Domestic rye grass	25	

If clover is desired, white Dutch clover seed should be added at the rate of one ounce per 5 lbs. of seed mixture. For best results, the soil should not be too acid. It is often necessary to lime the soil to insure good growth of clover. Seedings should be made in the spring. Fall seedings are risky because of possible winter kill.

UPKEEP

Spring Renovation

After the customary raking to remove dead leaves and the usual accumulations of over-winter rubbish, foot marks and other depressions should be smoothed with screened loam, the spring top-dressing of fertilizer applied, and bare patches should be reseeded. If rough or uneven, the lawn should then be rolled thoroughly. This is best done while the soil is still moist, but not so wet as to show a film of water on the surface when passed over by the roller.

Mowing

Very close mowing reduces the vigor of the turf especially when practiced in early spring. Blue grass is injured by short clipping. The first spring mowing should be deferred until the grass is at least two inches high. The height after cutting should be approximately one and one-half inches. If mowing is done regularly, when the grass is not more than two inches high, the clippings may well be left on the ground, thus adding some organic matter to the soil.

Watering

Many lawns, especially when situated on light sandy or thin soils, suffer severely from lack of moisture during the summer, especially during hot dry periods. Sprinkling with the ordinary hose, nozzle held in the hands, is laborious and is rarely effective. Much of the water runs off without soaking in, and the temptation is to water every day or so, without doing much more than wetting the grass leaves at any one time. If watering is to be worthwhile, it should leave the soil in a moist condition to a depth of at least two inches. This can best be accomplished by the use of mechanical sprinkling nozzles that distribute the water as a gentle shower for at least one-half hour over a single area. A thorough watering will provide enough moisture for four to seven days.

During hot, "muggy" weather, watering should be done only when absolutely necessary. At such times there are certain disease dangers induced by having the grass wet, especially on warm nights. Morning watering is desirable in these periods.

Fall Repair of Lawns

In September all patches where the turf has been destroyed by weed invasion, diseases or pests should be spaded up, fertilized lightly, and reseeded, using the same practices as for the seeding of a new lawn.

Thin turf, with no conspicuous bare spots, may be scratched deeply with an iron rake, all irregularities in the ground filled with screened loam, and seed scattered at about half the rate used for an initial seeding. Fertilizer used at this time should be applied a few days beforehand.

Late Fall Treatment

Mowing should be discontinued sufficiently early to permit the growth of two or three inches of grass before cold weather sets in. This means that under average conditions the last cutting should not be later than October 15. Heavy accumulations of tree leaves must be removed to avoid smothering the grass. Scattered leaves usually do no harm.

Some lawns in this vicinity are top-dressed with stable manure during the late fall. This is a good practice if the manure is sufficiently well rotted to destroy weed seeds. Fresh manure should not be applied to the lawn. When available, tobacco stalks and stems are often spread over lawns for the winter. It is doubtful if the plant food thus obtained is sufficient to justify the labor of fall spreading and spring removal of this material.

Soils deficient in organic matter may be gradually improved by top-dressings of peat made in the late fall. Too heavy application of peat should not be made for it will smother the grass. Usually the lawn should be covered with less than an inch of peat. Peat is not to be considered as a replacement for fertilizers for it is low in all of the fertilizer elements. Because of its high organic matter content it is a good soil conditioner. During the winter season, freezing and thawing action of weather will incorporate much of this material into the soil.

WEED CONTROL¹

A good stand of permanent grasses is the best control for weeds in the lawn. Since most lawn mixtures contain nurse or filler grasses such as red-top, ryegrass or timothy, holes may be left in the lawn when these grasses run out. When this occurs, immediate reseeding will help substantially in weed control.

Crab Grass

Crab grass usually gets into a lawn from imported loam or seed blown onto bare spots. It is very rarely present in commercial lawn mixtures and comes in where the permanent grasses are thin and less vigorous. Crab grass appears in the lawn about the first of June, and the seed continues to germinate throughout the season; therefore, complete eradication of existing plants is no guarantee that new plants will not appear.

Any measures which promote a vigorous turf will help crowd out crab grass. The weed may be controlled by using one of the new phenyl-mercury compounds, such as Tat-C-Lect or Puraturf. The material should be sprayed onto the young plants up to the four-leaf stage (or the manufacturer's directions may be followed). For successful kill the plant leaf surface must be thoroughly wet. Further applications may be necessary at five to seven day intervals. Spraying may have to be repeated when new plants appear during the summer, as this method, like other chemical control methods, may not be uniformly successful. Experimental data show that bent grasses and fescues are injured by phenyl-mercury compounds.

Dandelion, Wild Onions, Chickweed, Sheep Sorrel

Keeping the soil slightly acid may control these weeds with the exception of the sorrel, but once they are established one of the 2,4-D sprays may be helpful in killing them.

2,4-D is a selective herbicide which kills broad-leaf plants in general and leaves grasses unharmed. It is non-poisonous (unless oil carriers are used as in the ester formulations), non-inflammable and non-corrosive. Care to prevent drift during spraying is essential—a sunny day without wind is the best so that near-by ornamentals or vegetables will not be injured by drifting spray. The ester formulations of 2,4-D are volatile in the sun and may cause injury days after application. 2,4-D is also reported to injure bent grasses.

A separate sprayer for 2,4-D is an excellent idea as this chemical adheres closely to the inside of sprayer and nozzles and can be cleaned out only

¹ Acknowledgment is made to Frances W. Meyer for the preparation of this section.

with great difficulty. A minute amount of spray may cause a lot of damage when the sprayer is used for something else.

Variable success with the use of 2,4-D on dandelions has been reported: some tests indicate they grow back the following season; others that the dandelions are completely killed. 2,4-D may be used to rid the lawn of wild onions or garlic and common chickweed (*Stellaria*) and may be used as a spray or a dust, depending upon the user's preference. Some manufacturers offer a cardboard container similar to a can of talcum which is used in much the same manner. The presence of sheep sorrel in a lawn does not indicate acidity of the soil, as is generally supposed, but it may also be eliminated with 2,4-D as mentioned above.

The following lawn weeds are generally susceptible to 2,4-D. Sheep sorrel may need more than one treatment.

Buttercup	Knotweed
Cheeseweed	Plantain
Chickweed	Rough cinquefoil
Dandelion	Sheep sorrel
Honeysuckle	Wild garlic
Indian strawberry	Wild onion

The following plants are more or less resistant to 2,4-D.

Crab grass	Oxalis
Mouse-ear chickweed	Ox-eye daisy
Gout weed	Quackgrass
Leafy spurge	Violets
Milkweed	Yarrow

Weeds in Gravel Walks and Driveways

Borax sprinkled on the ground beside such weeds will kill them in time. This chemical is absorbed by the roots of the plants and kills slowly but very effectively. Care should be taken that the borax doesn't wash off onto the lawn or flowers, as it is toxic to all plants. Trees at a distance of 30 feet have been known to take up borax. Common table salt or calcium chloride may be used in the same manner.

Moss

Improvement of the soil is the only real cure for moss competition. The appearance of moss in a lawn does not necessarily mean the soil is acid, as is the popular belief, but rather indicates a lack of phosphates and potash. A soil analysis with accompanying recommendations will usually solve the problem. Moss may appear in sunny areas or in the shade, but reseeding after soil improvement will usually crowd it out.

Algae

Algae, the green slime often found in damp shady areas of a lawn, is often referred to as "moss". It is really a fresh water plant and may be eliminated by spraying with 1 teaspoon copper sulfate in 8 gallons of water, but the algae will return unless the condition which causes it is corrected. Admitting light to the area, improving the condition of the soil, particularly its drainage, and reseeding will push out the algae.

INJURIES AND DISEASES

There are a few fungus diseases which may cause injury to lawns, but injury from other causes is often mistaken for the symptoms of disease. The most common injury, often not recognized as such, is sunburn. This occurs after a few hot days following wet, cool weather. Since the various kinds of grass are burned differently, the injury often simulates definite areas of diseased grass. Sunburn obviously does not occur under trees.

Drought injury is a closely related trouble which is usually more widespread and occurs after prolonged dry spells. This injury shows first on thin soils exposed to full sun; later, shaded areas show injury. Heavy watering at the first signs of drought injury will forestall most of the trouble but after the grass has turned brown it will recover very slowly until cool fall weather.

Putting rugs or rubber mats on the grass on a hot day will burn the grass. In this case the burned area will conform to the shape of the object and diagnosis is easy. Burning of grass with chemical fertilizers has already been mentioned. Female dogs frequently cause circular dead areas on the lawn. Such areas later show a ring of dark green grass around the dead area.

Lawn Rot

New seedings and bent grass lawns are most likely to be attacked by this disease. It is caused by a fungus which attacks the grass during warm, humid weather producing a sudden rotting of the grass in irregular spots. These spots have a characteristic dark water-soaked appearance, quite unlike any other type of injury. This disease usually appears in areas fully exposed to the sun. The grass will recover from a light attack followed by dry weather but continued humid weather allows the fungus to completely kill the grass. This disease is difficult to control but frequent spraying with Bordeaux mixture or Tersan will help to check the spread. On new seedings it is suggested that treatment be started in late May or early June before the disease appears. Keep newly seeded areas as dry as the weather will permit. If watering is necessary, do it in the morning so the grass will dry quickly.

Snow Mold

This fungus disease develops under snow cover during the winter and appears as white spots on the lawn in the spring. Applications of fertilizer after September 15 produce a late luxuriant growth of grass and may predispose the lawn to infection by the snow mold fungus. Ordinarily this disease causes only temporary damage which disappears when growth begins in the spring, and control measures are not necessary. If a lawn is consistently attacked, treatment with a turf fungicide in late fall should reduce the severity of injury.

Copper Spot, Dollar Spot

These diseases are occasionally found on lawns but are of very minor importance. Copper spot appears as small circular copper-colored spots which are most conspicuous right after the lawn is mowed. The causal fungus is present only near the soil level and the symptoms can be seen only

when the grass has been cut. Dollar spot makes white spots about the size of a silver dollar, hence its name. This disease rarely occurs in the home lawn. Neither disease is of sufficient importance to warrant control measures.

Slime Molds

Frequently during wet weather patches of a bluish gray mold appear on the grass in the lawn. Another of these molds may appear as large masses of yellowish growth which are most unsavory in appearance. Neither of these organisms is parasitic on the grass and can do no harm except perhaps smother the grass in small areas. If necessary, the unsightly masses can be removed and the spot heavily dusted with sulfur or sprayed with Bordeaux mixture. Usually both organisms disappear with the advent of dry weather.

LAWN PESTS AND THEIR CONTROL

Japanese Beetle Grubs

Lawns are quite often partially or completely destroyed by white grubs, the most common of which is the larva of the Japanese beetle. Japanese beetle grubs feed on grass roots during most of the spring and summer months until the weather grows cool in the fall. The first sign of injury is a yellowing of the grasses; if grub feeding continues unchecked, the lawn will later appear straw-colored. A sure sign that Japanese beetle grubs are feeding in the lawn is loose turf, caused by destruction of the grass roots. Portions of the turf may be easily removed by scuffing or hand pulling. When grubs are numerous, the lawn may be destroyed completely unless control steps are taken.

Which Insecticide Should Be Used?

Three insecticides have given superior control of grubs of the Japanese beetle, Asiatic beetle, June beetle and other related species in our experiments. These are chlordan, DDT and parathion. Each has its advantages in certain situations. When a quick kill is desired, chlordan or parathion should be used. DDT is slower in its action, but will give residual protection for six years or more. Chlordan, besides being quick-acting, is known to give protection for at least two years. If protection of the turf beyond the season in which the insecticide is applied is of minor importance, parathion may be used effectively. It vanishes from the soil in the course of a season. Parathion is particularly toxic and should be handled with utmost caution.

Method of Application

Any of these insecticides may be used in either dust or liquid form. If used as a dust, the insecticide may be mixed with fertilizer to increase bulk of solids and thereby provide a more even and thorough distribution. Suitable fertilizers are "Milorganite", 8-6-2, 8-6-4 and 5-10-5. A hand-operated fertilizer distributor is a convenient means of application. Neither DDT nor chlordan should be applied with lime or used in the same season that lime is applied to the lawn.

In liquid form, the insecticide may be applied with a hand-operated or mechanical pressure sprayer. A watering can may be used for small scale applications. In all cases, the spray mixtures must be kept agitated to prevent settling of the insecticide.

The insecticides discussed may be applied to lawns at any time when the ground is not frozen. Early spring treatments are preferable, however, because they destroy the over-wintering grub population before irreparable damage results from the insects feeding on the grass roots. If the spring treatment is not made, a late August or early September application will give desired control before hibernation. Treatments will give fastest results if timed to precede a rain storm or if artificial watering is used immediately afterward to wash the material into the soil. This washing also protects children and household pets. Chlordan, DDT or parathion are all poisonous to some degree. Parathion is particularly toxic. For rates of application see Table 4.

Chinch Bug

Chinch bug injury may appear in lawns from mid-June until early fall. Early in the summer injured lawns have dead brown areas of irregular size and shape which grow larger and more abundant as the season advances. By autumn virtually all of the grass may have been destroyed, leaving only crab grass, weeds and clover. Chinch bugs are most injurious in bent, young blue grass and fescue lawns. Warm, dry weather favors the spread of this insect while wet weather in early summer when young chinch bugs are developing reduces the population materially.

The presence of the insect may be detected by examining the grass at frequent intervals at or close to the surface of the ground. The small ($\frac{1}{5}$ to $\frac{1}{8}$ inch in length) black, fast moving adults with white wings will be seen scurrying about in an effort to conceal themselves. The smaller brick-red immature stages may be seen also in great abundance wherever the infestation is serious.

Control

Chinch bugs may be controlled by either chlordan or DDT applied in dust form. As in Japanese beetle treatments, chlordan will give a faster kill than DDT but the residual protection afforded by DDT treatments is longer. The insecticide may be applied with fertilizer as described on page 12. Rates of application are given in Table 4. Fertilizing and watering lawns which have been injured by chinch bug and then treated with an insecticide encourages early recovery of the grass. Chlordan-treated lawns regain rapidly a vigorous growth of deep green grass, superior to turf treated with DDT. Where large patches of grass have been killed completely by chinch bugs, reseeding will be necessary.

Sod Webworm

Lawns composed of bent grasses or young blue grass are most seriously injured by sod webworms. Irregular brownish areas appear in turf where this insect is feeding. On close examination the grass near the irregular dead areas will be seen to be short and of an uneven height. When an outbreak is serious the lawn may acquire a moth-eaten appearance.

Adult moths of the webworms are dirty gray to yellowish brown in color. They remain more or less concealed during most of the day, coming out in late afternoon and evening.

Larval webworms chew off the blades of grass at the base, consuming them as they progress or drawing them into their tunnels to be eaten later. There are two to three generations a year, occurring from May through September. Since each generation may need to be controlled as it appears, no permanent insecticide treatment can be made which will assure seasonal protection.

Control

Lead arsenate has been used extensively for the control of sod webworms and gives fairly effective protection. However, when used several times a year for a few seasons, this treatment frequently creates a serious residue problem in the soil. Our experiments have shown chlordan to be an efficient insecticide for the control of this insect. A high mortality may be expected within 24 hours after treatment.

For best results the insecticide chosen should be applied in the late afternoon or early evening when the webworms are feeding. Rates of application are given in Table 4.

Cutworms

There are several species of cutworms which cause lawn injury. Most species are smooth, greenish, brownish or dirty white grubs with or without striping on the body.

Presence of the feeding larvae may be suspected if adult moths have been seen in the area. The moths are of medium size with a wing spread of from one to two inches. They are usually multi-colored of dull hues such as brown, blackish, gray or dirty white.

Cutworms are among the earliest insects to begin feeding in the spring. Most species have but one generation a year, although occasionally there are two. Generations usually overlap so that moths appear throughout the summer.

Cutworms injure grass by cutting off the blades at the base leaving small, elongated or irregular closely cropped brown spots in the turf. In general the larvae remain concealed just below the surface of the ground or in clumps of grass during the day, coming out at night to feed.

Control

Chlordan, DDT or lead arsenate will give effective control of cutworms, although lead arsenate has the disadvantage of possible injuriousness to grass with repeated treatments.

Any insecticidal treatment should be applied late in the afternoon to effect control during the night and the early hours of the following day. For cutworm control, sprays are preferred because they adhere well and can be uniformly distributed. Rates of application of these insecticides are given in Table 4.

Cutworm control on a small scale has been successfully accomplished by flooding the lawn with water until it is puddled. This treatment brings the cutworms to the surface where they may be collected and destroyed.

Poison baits have been used extensively in the past with some degree of success. Such baits contain sodium fluosilicate, sodium arsenite, Paris green or white arsenic. There is always the danger of children, animals and birds eating the bait unless it is well protected.

Ants

The cornfield ant is encountered in lawns more often than all other species and may be an annual problem for the homeowner. This is a little brown ant which builds small single or clustered anthills or craters in open soil and on the surface of the lawn directly above its nest. Construction of the mounds may take place at any time of day, most commonly, however, during the night. Moreover, no matter how frequently a crater may be destroyed, it will be rebuilt providing the colony has not suffered permanent injury.

Control

In our tests, chlordan has given efficient and dependable control of the cornfield ant, as well as other species which occur in lawns. It gives a quick kill and residual protection for several weeks.

Two methods of treatment with chlordan are suggested. Where nests occur infrequently or at least not in great abundance, the individual anthills may be treated separately. Chlordan wettable powder may be applied to the center of each anthill, followed by thorough watering to force the material into the galleries of the nests. A small portable pressure sprayer with the spreader removed from the nozzle may be used for this purpose. Water slowly poured from a watering can with the sprinkler removed may be used if a pressure sprayer is not available. An alternative method is to add one ounce of chlordan wettable powder to a gallon of water and pour a small amount of the suspension into each nest. Treated areas of the lawn should be thoroughly drenched with water subsequent to insecticide application to assure maximum penetration of the toxicant to the heart of the ant colonies.

Occasionally lawns are actually pock-marked with anthills. In this case chlordan should be applied in water suspension under pressure to the entire lawn. A hose and garden nozzle, the latter open as wide as possible, may be used for the purpose. Pressure at the spray tank pump should be maintained at about 100 pounds. Following treatment, the turf should be watered with 50 gallons of clear water to 1,000 square feet. If an occasional ant colony reappears after this complete application, it may be eliminated by the spot treatment method. Small hand pressure sprayer or watering can treatments are not efficient nor economical. Such treatment should not be undertaken unless mechanical spray equipment cannot be obtained.

Chlordan emulsion is equally efficient for control of ants. The insecticide may also be used as a dust. However, due to lack of quick penetration to the heart of the ant colonies, the efficiency of the dust treatment is not as great as that of the wettable powders and emulsions. For rates of application see Table 4.

Leafhoppers

In certain years when the weather is dry and hot, especially during the latter part of the summer and early autumn, grass leafhoppers may cause

serious injury to turf. There are several species involved, all of which discolor the grass by their feeding activities. Badly damaged lawns display an off color from gray to a light brownish yellow. The presence of the insects may be detected before serious trouble arises by walking back and forth over the lawn on a warm, clear day. When present, the leafhoppers will hop or fly in all directions as the motion of one's feet scatters them.

As soon as their presence is detected, DDT treatment should be applied, (see Table 4). Should reinfestation occur at a later date, the treatment must be repeated. One spray will not assure protection for the entire season.

Earthworms

Earthworms are beneficial soil-inhabiting animals. They are nature's tillers transporting soil from below the ground level to the surface. Constant changing of the upper layer of soil over a period of years improves materially its texture and fertility. Earthworms help to keep the soil open and pliable. Rain penetrates soil more readily when it has been made porous by their activity.

In the home lawn or other specialized turf areas, especially where the fertility and moisture are high, certain disadvantages sometimes arise from the presence of an excessive earthworm population. An abundant population casting at least once in 24 hours will cause smothering of turf unless the castings are broken up and scattered or removed each day. Moreover, castings clog mowing machines and dull the cutting blades. Earthworms in newly seeded lawns kill young grass plants by uprooting them.

It may not be necessary and certainly is not desirable to eliminate an entire earthworm population from a lawn. In consequence, a control measure should be applied only where earthworms occur in excessive numbers and are troublesome. DDT applied as a dust or wettable powder will kill a large number of adult earthworms and virtually all of the young. After two or three months, however, the population may be back to a normal status. Chlordan or toxaphene applied to excessive earthworm populations in the spring will destroy most of the earthworms present and prevent significant re-establishment for four or five months. Parathion kills all of the earthworms present at the time of treatment and keeps the turf largely free from reinfestation for six months or longer. For rates of application see Table 4.

Moles and Other Burrowing Animals

Moles, field mice, skunks and other burrowing animals are frequently troublesome in lawns. Since they feed on grubs of the Japanese beetle and related species, control of these insects will deprive the animals of their food and discourage invasion. Poison baits have been used to control mice with some success. Should moles continue to recur in turf which has been treated with an insecticide, they may be effectively controlled by the use of a standard mole trap.

TABLE 4. MATERIALS, QUANTITY TREATMENT, TIME FACTOR, ETC.

Insects	Materials	Rate of Application per 1,000 Sq. Ft.	Quantity of Water Used 1,000 Sq. Ft.	Time of Treatment Preferred
Japanese and Asiatic Beetle Grubs	DDT	6 lbs. 10% dust	25 gal. water	Early spring
		1-1/4 lbs. 40% W ¹ 1-1/2 " 50% W ¹ Emulsions—not less than 1/2 nor more than 2/3 lb. actual DDT in	" " "	
	Chlordan	5 lbs. 5% dust 10 oz. 40% W ¹ 1/2 lb. 50% W ¹ Emulsion—1/4 lb. actual chlordan in	25 gal. water " " " " " "	or Late summer
		Parathion	2-1/2 lbs. 1% dust 25 oz. 15% W ¹	25 gal. water
Native White Grubs (June beetles)	Chlordan	3 times the Japanese beetle rate	25 gal. water	Early spring or Late summer
Chinch Bug	Chlordan DDT	5 lbs. 5% dust 5-6 lbs. 10% dust		When necessary in the summer
Sod Webworms	Chlordan Lead Arsenate	5 oz. 50% W ¹ 2-5 lbs.	4 gal. water 20-50 gal. water	When necessary
Cutworms	Chlordan	6 oz. 40% W ¹ 5 oz. 50% W ¹ 5 lbs. 5% dust	2 gal. water " " " " " "	When necessary
		DDT	6 lbs. 5% dust 3 lbs. 10% dust	
	Lead Arsenate	3 lbs.	25 gal. water	
Ants	Chlordan	Spot Treatment 1/8 teaspoon of 40 or 50% W ¹ per nest Complete Treatment 6 oz. 40% W ¹ 4 oz. 50% W ¹ Emulsion — not less than 2 ounces actual chlordan in 10 lbs. 5% dust	75 gal. water " " " " " " " " "	When necessary
Leafhoppers	DDT	6 tablespoons 40% W ¹ 4 tablespoons 50% W ¹	5 gal. water " " "	Usually mid-summer through September
Earthworms	Lead Arsenate	10 lbs. dust		
	DDT	1 to 1 1/2 lbs. 50% W ¹ 5 lbs. 10% dust	10 gal. water	When necessary
	Chlordan or Toxaphene	20 lbs. 5% dust 2 lbs. 50% W ¹	" " " 10 gal. water	
	Parathion	3 1/2 lbs. 15% W ¹	50 gal. water	
Moles, etc.	Traps Baits			Control of white grubs discourages moles, etc.

¹ Wettable Powder.

If you are interested in "How Good Lawns Grow" and requested this circular, you may want to know about two other Station circulars on related subjects. These are:

**Circular 142—Peat and Swamp Muck
for Soil Improvement
in Connecticut**

Circular 146—Loams for Top-Dressing

Connecticut residents may receive these free of charge by sending a request to the Connecticut Agricultural Experiment Station, Box 1106, New Haven 4, Connecticut.