the soil is wet. Cultivation improves the structural porosity just as plowing improves the structural porosity of the field soil. Improvement of porosity allows better penetration of water. It allows for better diffusion of air. These conditions, in turn, promote deeper and more profuse root growth. On putting greens that have a tendency to form a thatch, dry spots often form. These are localized dry spots. Cultivation tends to break through the layers of thatch and thus prevent the formation of such dry spots. Cultivation aids the movement of fertilizer downward to the root zone. Cultivation is also important in seedbed preparation. Many turf growers have found that they can prepare a seedbed without complete destruction of established turf and without disturbing the existing level or contour of the surface. Plowing, or disking, on the other hand, completely destroys the turf that is present and frequently calls for a releveling job.

### *How Surface Is Affected*

Another question concerning cultivation is: "How does it affect the playing surface?" It is obvious that no kind of cultivation can be practiced on a putting green without doing some damage to the putting surface. The surface is roughened and must be smoothed again before putting can follow. There are many practices for accomplishing this end. Some operators break up the plugs after they have dried sufficiently by dragging with a flexible steel mat or a piece of chain-link fence. Other operators remove the plugs from the green. Whichever practice is followed, mowing will generally pick up the pieces of grass and small plugs that have not been worked back into the surface of the green, so that it is left in fairly acceptable condition. In some cases, it may be necessary to topdress with a better soil material than that which existed within the green.

One of the severe criticisms that the superintendent often hears from his members is that the greens are disturbed by cultivation at the very time that they are in the best condition of the season. It seems unnecessary to the golfer to disturb an excellent putting green by cultivation just at this time. It is important that golfers understand the need for this, because it is at the time when grass is growing best that cultivation can be done with the least amount of net harm. If the superintendent waits until the greens begin to slow in their growth and become poor, cultivation will leave its mark upon the green for a long time. If, on the other hand, cultivation is accomplished when the green is healthy and vigorous, the scars following the operation will be healed in a relatively short time and the green will recover completely within just a few days. Correct treatment of healthy grasses will often prevent their becoming sick later on.

It is expected that cultivation will come to be practiced with even less disturbance than accompanies it at the present time. However, the good that results from this practice so far outweighs the relatively small inconvenience that comes to the players that it is extremely important for golfers to appreciate the advantages resulting from the operation.

Turf management techniques have been revolutionized by the practice of cultivation with modern machinery. These developments tend to make the superintendent's job a little easier and his turf a great deal better.

## Soluble, High Analysis Fertilizers — 1954

In November, 1950, an article appeared in the USGA JOURNAL titled "What about Liquid Fertilizers?" Our readers were urged to examine carefully the prices of liquid fertilizers in comparison to the conventional, dry-type fertilizers. It was pointed out that liquid fertilizers had some special uses but ordinarily they could not hope to compete with conventional fertilizers in expense or ease of handling.

The picture has changed somewhat in the four years since publication of that article. The use of these materials has been increased remarkably by farmers, garden-

ers, commercial vegetable growers, golf courses and other turf users. These materials are now a substantial part of the fertilizer trade. The technology of fertilizer manufacture and fertilizer handling has made rapid advances during recent years. It is now possible to buy liquid fertilizers and soluble fertilizer materials that have high analyses and approach very closely the conventional fertilizers in price.

Soluble fertilizers can be bought in two ways. They can be bought in dry form and be dissolved in water by the user, or they can be bought in liquid. There are certain advantages accompanying the use of high analysis fertilizers. They require less storage space, less handling and less cost for shipment. The soluble materials are clean. They are usually odorless, and they can be dissolved in water and automatically metered into irrigation water by syphon attachments. Those fertilizers which are marketed in the liquid form have the disadvantage of being more difficult to ship and of requiring more expensive containers.

Readers still are urged to judge fertilizers on the basis of values of the plant food contained in the fertilizers and upon the ease of application. Four years ago there were relatively few completely soluble fertilizers that could be called high-analysis materials. At the present time, fertilizers can be obtained that have as much as 61 per cent of total primary nutrients. Several examples are given here. A 23-21-17 fertilizer can be made from ammonium phosphate, urea and potassium nitrate. This fertilizer contains 61 per cent of total primary nutrients. Another one is a 20-20-20. This is made from a mixture of monoammonium phosphate, diammonium phosphate, urea and potassium nitrate. It contains 60 per cent of total nutrients and you will note that it is in the 1-1-1 ratio, which is quite popular among all types of growers. Still another one is a 15-10-14 fertilizer, containing 39 per cent total primary nutrients. This fertilizer is made from mixtures of ammonium phosphate, ammonium sulfate, and potassium nitrate. It is in the approximate ratio of 3-2-3 and might be a fairly good fertilizer for putting green purposes where there is a high concentration of phosphorus already in the soil.

### *Mixing One's Own*

There are a great many fertilizer mixtures of this type available on the market. It is possible, of course, to buy the fertilizer materials and mix them as needed. The table on the next page shows a number of high-grade nutrient sources and plant food content. If one does mix his own, there are a number of things that he must guard against. Some of these are inert ingredients that are insoluble and which may clog the syphon or the sprinkler. Compatibility of the materials used is important. Some of them may cause a reaction which will result in some insoluble precipitate which may clog the applicator or they may cause loss of ammonia gas. It is necessary to be sure that one does not mix materials together which will give one of these results. The user should also be familiar with the nitrogen source of the nutrients he is using. In cold weather, nitrification is slow; therefore, he should not use all urea or ammonia during the cool season. There should be some nitrate in the mixture so that it will be available immediately to the plant.

It might be well to point out that some soluble fertilizers have urea as the source of nitrogen. Urea is frequently spoken of as an organic nitrogen. Actually, it is a synthetic material that is completely soluble in water and needs only to go through the nitrification process to become available in the form of nitrate. Urea, while it is technically an organic source of nitrogen, behaves very much like inorganic sources of nitrogen. Therefore, users should not be misled into believing that they are using a material that will behave in the same manner as conventional organic fertilizers on their turf.

Another precaution is to make sure that tanks or irrigation systems are flushed out thoroughly with water following the use of soluble fertilizers. Many of them have a corrosive action when they are allowed to remain in contact with metals.

It is necessary that sufficient water be used with liquid fertilizers, or soluble fer-

tilizers, to prevent damage to the grass plants. Tests have indicated that the amount of fertilizer in water might vary from one-tenth of one per cent to 3 per cent, depending upon the season of the year and the type of plant which is being treated. It is believed that golf-course superintendents should confine their fertilizer irrigation water mixtures to the lower part of this range. In other words, one-tenth of one per cent of fertilizer in water means roughly one pound of fertilizer to 125 gallons of water. It is believed that it will be absolutely safe to use liquid fertilizers on any of the grasses that are grown on golf courses if the concentration of fertilizer is kept to this level. One may find from his own experience that he can increase the concentration of fertilizer a great deal, but he should certainly start with a relatively low concentration.

| | *Nutrient Content* | | |
|---|---|---|---|
| *Source of Nutrients* | *N* | $P_2O_5$ | $K_2O$ |
| Ammonium nitrate | 33.5 | 0 | 0 |
| Ammonium sulfate | 20 | 0 | 0 |
| Sodium nitrate | 16 | 0 | 0 |
| Urea | 46 | 0 | 0 |
| Diammonium phosphate | 21 | 53.8 | 0 |
| Monoammonium phosphate | 12.2 | 61.6 | 0 |
| Potassium nitrate | 13.7 | 0 | 46 |
| Dipotassium phosphate | 0 | 40 | 53 |
| Monopotassium phosphate | 0 | 51.6 | 34.2 |
| Muriate of potash | 0 | 0 | 62 |

## CONSERVING SEED

Probably seed mixtures will cost about 50 per cent more than they did last year. The relatively light 1953 crop of Kentucky bluegrass has increased the demand for other permanent grasses and thus the price for all grasses has gone up. Therefore, these recommendations may be helpful.

1. Buy a mixture that exceeds minimum specifications for permanent grasses.
2. Buy the type of mixture seed that is suited to your needs.
3. Buy no more seed than you need.
4. Prepare the seedbed thoroughly—never sow seed except on a well-prepared seedbed.
5. Seed in early fall (especially in southeastern New York) or in early spring. Don't gamble with off-season seeding.
6. Fertilize your lawn with a complete fertilizer at planting time.

*From the Westchester County Farm and Home News, March, 1954.*

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To assist the USGA Green Section to sponsor research on turf and its management and to help educate turf workers, the following have subscribed to the Green Section's new Research and Education Fund:

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