Getting Back To Basics -Turfgrass Fertilization

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Few horticultural professions involve the variety and complexity of problems one finds on a golf course. Turfgrasses are probably the most intensively managed crop in agriculture and with rigid and complex maintenance programs comes problems.If grass management was all tht one encountered on a golf course, the problems would be relatively simple. But there is much more than grass to be concerned with. There are soils, fertilizers, machines, trees, shrubs, flowers, weeds, pests, chemicals irrigation systems, etc., etc. And probably worst of all there are peoples problems. Thus the professional superintendent must be an agronomist, horticulturist, engineer nematologist, psychologist, and ad infinitum.

For those individuals who look at these compleities as challenges to their knowledge and skill, the job can be exceedingly rewarding. The types of skills and expertise one needs to be a professional superintendent are many and varied. But, one does not have to have a Ph. D. in all these subjects. On the contrar, probably the best turf managers are those individuals who have a broad and general understanding of the basic concepts of plants and soils. It is the "putting together"of all the pieces of basic information, in the right order, which separates a greens keeper from a professional golf course superintendent.

One of the pieces of knowledge which is vital for continued success is a basic understanding of "Turfgrass Fertilization." Proper fertilization involves much more than a superficial knowledge of fertilizers. Proper fertilization must include an understanding of plant nutrition, soil science, and fertilizers. A basic understanding of these three subjects is essential in managing turfgrasses as well as all ornamental plants.

PLANT NUTRITION

Perhaps the most basic concept one learns in plant science and one of the most important concepts a turf manager must understand is the "Theory of the Limiting Factor."

Six external factors are generally recognized as necessary for normal plant growth. They are:

1. Light - intensity, quality and duration.
2. Heat - proper temperature for growth.
3. Air - for leaves and roots.
4. Water - quantity and quality.
5. Nutrients - around 16 essential.
6. Medium - something to grow in.

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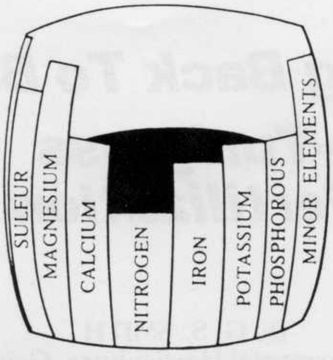
It is very important to remember that plant growth is dependent upon a favorable level and combination of these factors and that any one of them, if lacking or out-of-balance, can reduce or even stop plant growth. Furthermore, the factor which is *least optimum* will determine the level of growth. This theory of limiting factors can be simply stated as follows:

"The level of turf production (quantity and quality) can be no greater than that allowed by the most limiting of the essential growth factors."

Perhaps several examples will further stress this important concept in turf management.

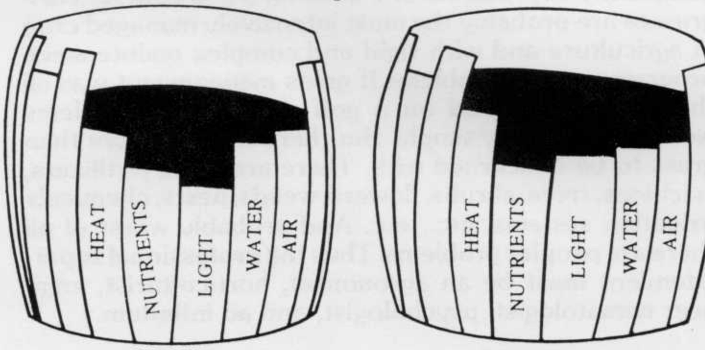
First, consider the situation of a very shady tree. Obviously the grass is growing poorly. But why? The limiting factor concept gives the answer (see Figure 1). In figure 1, let the level of turf quality by represented by the level of water in the barrel. The water level (turf quality) can rise no higher than allowed by the limiting factor which is light. All other factors are adequate but quality is limited by this one essential factor. If the tree is thinned and the grass receives more light, the level of turf quality can rise accordingly. Now in this example, the level of quality is limited by nutrition.

Before considering a further example, let us be more specific about turfgrass nutrition.



NITROGEN LIMITING GROWTH
IRON SECOND MOST LIMITING

Figure 3.



LIGHT LIMITING

NUTRIENTS LIMITING

Figure 1.

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ESSENTIAL NUTRIENTS

All plants require certain chemical elements. These nutrients are called the essential elements. For an element to be regarded as essential it must fulfill the following requirements:

1. **Without the element, a plant cannot complete its life cycle.**
2. **The action of the element must be specific; no other element can wholly substitute for it.**
3. **The element must be shown to be directly involved in the nutrition of the plant.**
4. **The element should be shown to be required for higher plants in general.**

Around 1900 there were only 10 elements listed as being essential for plants. Today we recognize six additional essential elements so the list reads as follows:

Carbon	Nitrogen	Iron
Hydrogen	Phosphorous	Manganese
Oxygen	Potassium	Zinc
	Calcium	Copper
	Magnesium	Molybdenum
	Sulfur	Boron
		Chlorine

The first step in proper fertilization is to realize that *all* turfgrasses require *all* 16 essential elements. The nutrients must be present in adequate amounts and proportions. The next two points to consider are: (a) Where do these elements come from; and (b) What do you do if one or more are lacking?

Figure 2 lists the sources of the essential elements. Higher plants obtain most of their carbon and oxygen from the air. The hydrogen is derived from water. All of the other essential elements are obtained from the soil via plant roots, in most situations. We have very little influence over the supply of carbon, hydrogen and oxygen and fortunately these three elements are seldom limiting. Ordinarily, from 94-99% of the plant is made up of these three elements and only 1-6% of a plant is composed of the other elements. In spite of this fact, it is the nutrient elements obtained from the soil which usually limit turf production. Fortunately, we can have a direct effect on the essential elements supplied by the soil the esentil elements supplied by the soil solution. All of these elements can be added to the soil and thus to the plant through the application of various fertilizers.

Now let us return to the limiting factor concept as it relates to turf nutrition and fertilization. Assume in this second example that all factors for growth are adequate except for nutrition (Figure 3). A good example would be a sod suffering from lack of nitrogen. Here is the situation as portrayed by the barrel where nitrogen is the limiting factor (Figure 3). Turf quality can be no higher than that allowed by the level of nitrogen. If one is lucky enough to know that nitrogen is deficient, the problem is easily corrected by adding a nitrogen fertilizer. But now what happens? Turf quality rises until it is limited again by the most limiting factor. In this case, iron. So to increase quality any further, iron must by applied.

Of course this example could be carried on and on. But where does it lead us? It leads to this conclusion.

"All factors needed by plants - light, heat, air, water, and nutrients - *must* by available in adequate suplies and proper proportions before optimum quality cn be achieved." One or more factors or combinations will always limit turf growth. The job of turf grower is to maintain adequate levels of all growth factors so that turf production is always at an acceptable level.

ESSENTIAL ELEMENTS

MACRONUTRIENTS			MICRONUTRIENTS	
AIR WATER	SOIL		SOIL	
Carbon	Nitrogen	Calcium	Iron	Copper
Hydrogen	Phosphorous	Magnesium	Manganese	Molybdenum
Oxygen	Potassium	Sulfur	Zinc	Boron
				Chlorine

Figure 2. Essential Elements Required by Turfgrasses and Their Sources.

SOIL SCIENCE

Basic soil science is a second subject one must be familiar with when planning fertilization program. So far it has
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Purple Nutsedge

(Cyperus rotundus L.)
(Coco-Grass)

By STEVE BATTEN

Purple nutsedge is not the most common sedge in golf course course turf in Florida, but it is the most difficult to control. A native of Eurasia, purple nutsedge headed the list of the 10 worst weeds in the world according to Leroy Holm in *Weed Science* in 1969.

The thin 2-6 mm wide flat leaves have a defined rib vein which can be felt by hand on the back of the leaf. Seed stalks are triangular in circumference with seed spiklets varing from 3-9 per plant. The reddish purple to reddish brown seeds give way to the name purple nutsedge.

The nuts or turbers are formed on thin rhizomes. These rhizomes and tubers are the main reason purple nutsedge is difficult to control, but these are also the key to successful control.

Repeated applications of organic arsentical herbicides such as MSMA have been shown to be effective only if continual application is made at bi-weekly intervals. As new shoots reoccur from the tubers, another MSMA application will reduce them. Finally after enough applications are made with MSMA, the total population of purple nutsedge is reduced, but not necessarily killed. Persistence is the answer to control.

Research by southern universities have shown that the early stage of plant development or early in the summer is the best time for successful nutsedge suppression.

Fumigation with methyl bromide is a very effective way to control the tubers of purple nutsedge. This is one more reason why fumigation is important during putting green construction. ■

Illustration by Steve Batten

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been agreed that optimum quality can be realized once all essential growth factors are supplied in adequate amounts and in proper proportions. This sounds very simple but can actually be rather complex. We know which elements plants require but the problems then become:

(1) How much of each essential element is adequate or optimum?

(2) How can these elements be supplied? In what form and how often?

SOIL TESTING

Over the last twenty years, research in Florida has fairly well defined the minimum and optimum levels of several of the essential element in both turfgrasses and soil Table 1 summarizes the desirable soil pH range and minimum nutrient levels of several elements in soils. If these levels are maintained in the soil, deficiencies of these four elements should not occur.

These soil nutrient levels are one of the measurements you should use when determining a good fertilization program. Soil testing is not, however, the cure-all for all your problems. Rather it is only one tool at your disposal.

A few cautions need to be stated at this point. There are many laboratories which analyze soils and most are reliable. Choose one lab and let them do the testing and give recommendations. Do not try to compare labs and their recommendations. Testing procedures vary from lab to lab and from state to state and their fertilization recommendations are based on their own testing procedures. Soil tests are only useful if they have been correlated with turf responses. So, again, use one reputable lab and follow their programs unless they seem way out of line.

The University of Florida Soil Testing Lab will routinely give you the following information: soil texture, organic matter, pH, and the pounds per acre of calcium, magnesium, phosphorous and potassium. Nitrogen is also reported but values are of little use. The example shown here would be a very good nutritional level for growing bermudagrass. Use your soil analysis results to help you decide on a fertilizer program.

TABLE I. SUGGESTED SOIL pH RANGES AND MINIMUM NUTRIENT LEVELS FOR FLORIDA LAWN GRASSES*

Grass	pH	CaO (Calcium)	MgO (Magnesium)	P_2O_5 (Phosphorus)	K_2O (Potassium)
		Pounds Per Acre			
Bermuda					
St. Augustine	6.0-6.5	1200	150	50	150
Zoysia					
Bahia					
Carpet	5.5-6.0	600	100	40	100
Centipede					

* Based on acid ammonium acetate extraction.

An obvious shortcoming of soil testing is this - it only tells you the levels of C., Mg, P, K and soil Ph. It does not provide information of levels of S, Fe, Mn, Zn, Cu, Mo, B

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and gives little useful data on N in the soil. Luckily, these elements, with the exception of nitrogen, are required in relatively small amounts and need be supplied fairly infrequently. Also, they are often applied as constituents of other fertilizers such an natural organics.

FERTILIZERS

A detailed discussion of all the fertilizers used on turf is beyond the scope of this paper. For information on basic turf fertilizers I would refer you to the paper by Mr. Ralph F. Jones entitled "Fertilizers—Basic Chemicals," published in the 1969 FT-GA Proceedings. For a very comprehensive publication on fertilizers, obtain a copy of "Fertilizers and Fertilization," by Dr. G.M. Volk, Soils Chemist, University of Florida. This Extension Bulletin may still be available from your County Extension Service. Specific turfgrass fertilization recommendations can be found in the Extension Circular 357, "Turfgrass Fertilization" by H.G. Meyers and G.C. Horn.

The remainder of this discussion will cover general types of fertiliers used on turfgrasses, understanding the fertilizer tag and sources and characteristics of primary plant foods.

THE FERTILIZER TAG

First of all let us take a close look at a fertilizer tag. An understanding of the fertilizer label can prevent many problems such as waste of maney, waste of materials, damage to turf and needless ependitures for materials containing unnecessary components or the wrong kind of ingredients.

Fertilizers are identified by analysis and/or by brand name. The more common commercial fertiliers are usually known by the analysis numbers such as 6-6-6 or 16-4-8. Many specialty fertilizers are referred to by brands such as Blue Chip, Milorganite, Turf Special, etc. Regardless of how the material is named, the important information must be printed on the label.

The analysis numbers, such as 6-6-6 or 16-4-8 give the percent nitrogen, available phosphoric acid, and water-soluble potash, respectively. The numbers represent percentages or units in fertilizer terminology. Thus a 100-pound bag of 16-4-8 contains 16 pounds of nitrogen, 4 pounds of available phosphoric acid and 8 pounds of water-soluble potash. These three elements are called the available primary plant foods and are often used as the name of the fertilizer, for example, 16-4-8.

In addition to the primary elements, the fertilizer may contain secondary plant foods. These are also reported on the label, at the bottom, if they are guaranteed present. The secondaries include calcium, magnesium, sulfur, manganese, zinc, copper, boron, iron and molybdenum. The last six (Cu, Mn, Zn, B, Fe, Mo) are called micronutrients.

The label also gives you the materials from which the fertilizer has been made. This information is listed beside the *derived from* from statement. Chlorine content is also listed since it may be injurious to some plants.

SOURCES AND CHARACTERISTICS OF PRIMARY PLANT FOODS

With a closer look at the fertilizer label you will see that the percent nitrogen is subdivided into four different forms. Since nitrogen is the backbone of your fertilization program and the major expense, it is critical to understand the different types of nitrogen and the advantages and disadvantages of each. In most instances, a satisfactory fertilization program can be achieved using any one or combination of many nitrogen materials. However, it is absolutely essential to understand the characteristics of each material and to use them accordingly.

The four forms of nitrogen listed on the label are: nitrate N, ammoniacal N, water-soluble organic N (a very misleading form of N) and water-insoluble N.

Rather than discussing these forms individually, let's look at the types of N fertilizers as they are related to turf availability and response. For ease of discussion, nitrogen fertilizers may be divided into three groups: (1) immediately soluble and available sources, (2) synthetic organic sources, and (3) natural organic sources.

In the immediately available group is ammonium nitrate, ammonium sulfate, calcium nitrate, nitrate of soda, and urea, a material often listed as a synthetic organic source. This form of nitrogen, urea, should be considered as equivalent to ammoniacal N since it is readily available. It should never be thought of as a slowly available organic nitrogen source. These fetilizers are often called soluble, readily available, inorganic or chemical N fertilizers. They contain nitrate and/or ammoniacal nitrogen and they have the following advantages and disadvantages:

Inorganic Nitrogen Sources

Advantages	*Disadvantages*
Readily available N	Leach readily
Low cost per unit of N	High salinity potential
Can easily control N levels	Danger of fertilizer burn
Little problem of residual N	Must be applied at low rates, frequently
May have greater efficiency	High Labor costs since frequently applied
	Acid forming

In the natural organic category are materials such as activated and digested sewage sludges, guano, cottonseed meal, castor pomace, and certain animal byproducts. Practically all of the nitrogen in these products is water-insoluable N. Water-insoluble Nitrogen cannot be used directly by the plant but must be converted to ammoniacl and nitrate nitrogen by soil micro-organisms.

Natural Organic Nitrogen Sources

Advantages	*Disadvantages*
Slow release of N, thus no rapid growth flushes; less subject to leaching	May be very expensive
Seldom burn turf	Don't release N in cool weather
Can apply more at one time so reduced labor costs	Usually low in N so large volume must be handled
Supply P, K and Micronutrients	Less control over N levels

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The last group to consider are the synthetic organic nitrogen materials. If urea is not considered in this group for reasons already covered, it includes only two types, urea formaldelyde and isobutylidine diurea. The former is commonly called UF or ureaform, while the latter is known as IBDU.

Ureaform is a material containing about 38% nitrogen made by chemically combining urea and formaldelyde. This material must be converted to ammoniacal and nitrate nitrogen by soil organisms before it can be used by plants. However, it does contain some simple urea whose nitrogen is imediately available. For the most UF materils, approximately one-third of the nitrogen is rapidly available, one-third moderately available, and one-third so slowly available that it must be built up to considerable quantity in the soil to release nitrogen in significant amounts.

Since UF fertilizers are high analysis, light weight, slow release materials they combine easy handling, safety in application and low application costs. Their disadvantages include high cost per unit of nitrogen, poor effectiveness in cold, wet periods, and high residual levels needed for prolonged nitrogen release.

IBDU is a relatively recent addition to the synthetic orgnic nitrogen category. It contains 31% nitrogen and releases nitrogen slowly as the particle dissolves in the soil water. IBDU releases nitrogen even in cool weather since it is not directly dependent on soil microorganisms for conversion to an available form. Several advantages of IBDU are its lack of superfluous, rapidly available nitrogen which produces excessive flushes of growth and its apparent safety even when applied at high rates. IBDU is not, however, the perfect material for turf fertilization. It has a high cost per unit of nitrogen and releases nitrogen constantly as long as soil mosture is available. This means that too much nitrogen could be released during rainy periods or under heavy irrigation, even when turf may be needing little nitrogen. Also, a satisfactory fertilization program with IBDU will be dependent upon a well designed and operating irrigation system.

Now just a few comments on phosphorous and potassium fertilizers. These materials are applied much less frequently than nitrogen. They may be applied in combinations with nitrogen in complete fertilizers or individually in various materials.

Available phosphorous comes mainly from superphosphate, ammonaited superphosphate and triple superphosphate. Maintain the soil P level at 50 pounds per acre as determined by our soil test. Most golf greens contain enough P from complete fertilizations in the past to last many years.

Potassium levels can be adjusted as indicated by soil tests by addition of materials like muriate of potash, sulfate of potash magnesia, nitrate of potash, sulfate of potash and nitrate of soda potash. A general rule of thumb to remember is to apply 2 1/2 to 5 pounds of K per 1,000 sq. ft. per year or about 1 pound of potassium for every 3-4 pounds of nitrogen applied.

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SUMMARY

If I can possibly summarize this discussion on turf fertilization, it might be something like this:

A healthy, well-maintained golf course can be a beautiful landscape which has great functional and aesthetic value. However, such an environment doesn't just happen! It is the result of a lot of hard work and is realized only if its plants are grown under near ideal conditions. This includes adequate light, air, water, proper temperatures, a suitable soil to grow in and a supply of essential nutrients.

A good fertilization program is a vital part of your management system and one tool you have control over. Proper fertilization involves a basic understanding of plant nutrition, soil science and fertilizers.

There is probably *no single magical* fertilizer or fertilization program even though there are frequent claims to that effect. First, realize that all plants require the same essential elements in proper amounts and proportions. Several nutrients like nitrogen, phosphorous and potassium are required in much greater quantities than others but all 16 are essential. Secondly, use soil testing only as a guide to help you decide when and how much phosphorous, potassium, calcium and magnesium are needed and if soil pH needs to be adjusted. And finally, design a nitrogen fertilization program to produce acceptable quality turf for your particular golf course. In most instances, a satisfactory nitrogen fertilization program can be achieved using one or several materials. The critical thing is to understand the charcteristics of each material and to use them accordingly. One material may be easier to apply, safer, less expensive to buy or apply, or more effective than another in any given situation. But, there is no perfect recipe for all turf. You must formulate your "best" program for your conditions. You can achieve this goal if you understand the basic principles we have covered in this discussion. ■

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New From Lebanon

Now available for fall fertilization — Country Club 8-4-24, a new homogenous formulation with 30% WIN and 100% Sulphate of Potash. It is specifically designed for three specific turf applications:

(1) Fall and Late Fall Feeding.
(2) Where Potash Levels are Low.
(3) Where Low Nitrogen and Higher Potash is Desired.

With one simple application during the growing season, Country Club 8-4-24 will help insure winter and summer hardiness, increase disease resistance, and promote more erect growth.

New sandtrap rakes with fiberglass handles are available now from LESCO, Inc., Rocky River, OH.

The more durable fiberglass handle will not warp. The yellow color has been molded in and not painted on. In addition to the change in the handle, improvements have been made to the rake mold to make available a rake head with or without a spike. Heads to fit the standard wooden handle LESCO trap rake will be available, too, with or without a spike. The rake heads will continue to be available in yellow or black.

The new fiberglass handle LESCO TRAP RAKE joins the complete line of golf course accessories and turfgrass equipment replacement parts available from LESCO, Inc.

Fertilizers — Basic Chemicals

By RALPH F. JONES

Fertilizers supplement the fertility of the soil and supply the essential elements plants use to manufacture their own food.

Plants require 17 essential elements for normal growth. Three of these elements, carbon, hydrogen and oxygen, come from air and water. These elements are needed in large quantities and are necessary for the production carbohydrates, fats and protein. The elements that are supplied by the soil and/or the application of fertilizers include the primary, secondary, and trace elements. The primary elements are nitrogen, phosphorus, and potassium. The secondary elements include calcium, magnesium, and sulfur plus sodium, which has been added to the list recently. The trace elements include manganese, iron, copper, zinc, boron, molybdenum and chlorine. Chlorine is not considered an essential ingredient of fertilizers as there normally is an abundance of this element. We generally are more concerned with an over supply of chlorine than a shortage.

The essential elements each have certain functions in the plant. There are also a number of materials available that contain these elements in a plant-usable form. In order to acquaint you with some of the main functions of these elements and the available materials, each element will be listed with this information given. The plant food content of each material will be given in either the elemental or oxide form and in some cases both. In Florida, most elements are guaranteed as oxides. Please note that some materials are listed under more than one heading as they supply more than one essential element.

Nitrogen — Promotes growth and color, necessary for protein formation

Natural organic nitrogen materials

Sewage sludges	5% to 6% N
Castor Pomace	4% to 6% N
Cotton Seed Meal	4% to 7% N

Synthetic organic nitrogen materials

Urea (all water soluble)	46% N
Ureaform (mostly water soluble)	38% N

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Chemical Nitrogen Materials

Ammonium Nitrate	33.5% N
Ammonium Nitrate Limestone	20% N
Ammonium Sulphate	21% N
Nitrate of Soda	16% N
Potassium Nitrate	13% N
Monoammonium Phosphate	11% N
Diammonium Phosphate	16% to 21% N

Phosphorus — Promotes root development and seed formation

Sources

Superphosphate	18% to 20% P^2O^5
Triple Superphosphate	42% to 56% P^2O^5
Monoamonium Phosphate	48% to 60% P^2O^5
Diammonium Phosphate	46% to 53% P^2O^5

Potassium — Necessary for cell division, builds structure, hardens plants, increases disease resistance.

Sources

Muriate of Potash	60% to 62% K^2O
Sulphate of Potash	48% to 50% K^2O
Potassium Nitrate	44% K^2O
Nitrate of Soda—Potash	14% K^2O

Calcium — Stimulates root and normal leaf development, corrects soil acidity

Sources

Dolomitic Limestone	22% Ca	30% CaO
Hydrated Lime	54% Ca	75% CaO
Superphosphate	20% Ca	28% CaO
Calcium Sulphate (gypsium)	22% Ca	30% CaO

Magnesium — Necessary for chrorophill formation

Sources

Dolomitic Limestone	11% Mg	18% MgO
Magnesium Sulphate	18% Mg	29% MgO
Sulphate of Potash Magnesia	11% Mg	18% MgO

Sulphur — Necessary for protein formation and chlorophill development

Sources

Superphosphate	12% to 14% S	30% to 35% So^3
Calcium Sulphate	15% to 18% S	37% to 45% So^3
Sulphate of Ammonia	23% S	57% So^3
Sulphate of Potash	17% S	42% So^3
Magnesium Sulphate	24% S	60% So^3

Sodium — May be utilized by the plant in place of potassium but cannot be used to replace all potassium in the plant. Normally not considered a necessary element in a fertilizer program. Nitrate of soda is a material that contains sodium.

Manganese — Necessary for metabolism and photosynthesis

Sources

Manganese Sulphate	23% to 25% Mn	29% to 32% MnO

Iron — Essential for chlorophyll formation

Source

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